

## CYTOKINE ANTAGONIST MOLECULES

This invention relates to novel proteins (termed INSP052 and INSP055), herein identified as immunoglobulin domain-containing cell surface recognition molecules and to the use of these proteins and nucleic acid sequences from the encoding genes in the diagnosis, prevention and treatment of disease, for instance in the diagnosis, prevention and treatment of inflammatory diseases, auto-immune diseases, skin diseases, liver disease or liver failure.

All publications, patents and patent applications cited herein are incorporated in full by reference.

### 10 BACKGROUND

The process of drug discovery is presently undergoing a fundamental revolution as the era of functional genomics comes of age. The term "functional genomics" applies to an approach utilising bioinformatics tools to ascribe function to protein sequences of interest. Such tools are becoming increasingly necessary as the speed of generation of sequence data is rapidly outpacing the ability of research laboratories to assign functions to these protein sequences.

As bioinformatics tools increase in potency and in accuracy, these tools are rapidly replacing the conventional techniques of biochemical characterisation. Indeed, the advanced bioinformatics tools used in identifying the present invention are now capable of outputting results in which a high degree of confidence can be placed.

Various institutions and commercial organisations are examining sequence data as they become available and significant discoveries are being made on an on-going basis. However, there remains a continuing need to identify and characterise further genes and the polypeptides that they encode, as targets for research and for drug discovery.

25 Recently, a remarkable tool for the evaluation of sequences of unknown function has been developed by the Applicant for the present invention. This tool is a database system, termed the Biopendium search database, that is the subject of WO01/69507. This database system consists of an integrated data resource created using proprietary technology and containing information generated from an all-by-all comparison of all available protein or  
30 nucleic acid sequences.

The aim behind the integration of these sequence data from separate data resources is to

combine as much data as possible, relating both to the sequences themselves and to information relevant to each sequence, into one integrated resource. All the available data relating to each sequence, including data on the three-dimensional structure of the encoded protein, if this is available, are integrated together to make best use of the information that is known about each sequence and thus to allow the most educated predictions to be made from comparisons of these sequences. The annotation that is generated in the database and which accompanies each sequence entry imparts a biologically relevant context to the sequence information.

This data resource has made possible the accurate prediction of protein function from sequence alone. Using conventional technology, this is only possible for proteins that exhibit a high degree of sequence identity (above about 20%-30% identity) to other proteins in the same functional family. Accurate predictions are not possible for proteins that exhibit a very low degree of sequence homology to other related proteins of known function.

## **15 SIGNAL PEPTIDE-CONTAINING PROTEINS**

The ability of cells to make and secrete extracellular proteins is central to many biological processes. Enzymes, growth factors, extracellular matrix proteins and signaling molecules are all secreted by cells. This is through fusion of a secretory vesicle with the plasma membrane. In most cases, but not all, proteins are directed to the endoplasmic reticulum and into secretory vesicles by a signal peptide. Signal peptides are cis-acting sequences that affect the transport of polypeptide chains from the cytoplasm to a membrane bound compartment such as a secretory vesicle. Polypeptides that are targeted to the secretory vesicles are either secreted into the extracellular matrix or are retained in the plasma membrane. The polypeptides that are retained in the plasma membrane will have one or more transmembrane domains. Examples of signal peptide containing proteins that play a central role in the functioning of a cell are cytokines, hormones, extracellular matrix proteins, adhesion molecules, receptors, proteases, and growth and differentiation factors.

## **IMMUNOGLOBULIN DOMAIN-CONTAINING CELL SURFACE RECOGNITION MOLECULES**

30 Immunoglobulin domain-containing cell surface recognition molecules have been shown to play a role in diverse physiological functions, many of which can play a role in disease

processes. Alteration of their activity is a means to alter the disease phenotype and as such identification of novel immunoglobulin domain-containing cell surface recognition molecules is highly relevant as they may play a role in many diseases, particularly inflammatory disease, oncology, and cardiovascular disease. Immunoglobulin domain-

5 containing cell surface recognition molecules are involved in a range of biological processes, including: embryogenesis (Martin-Bermudo, M.D. *et al*, Development. 2000 127(12):2607-15; Chen, L.M., *et al*, J Neurosci. 2000 20(10):3776-84; Zweegman, S., *et al*, Exp Hematol. 2000 28(4):401-10; Darribere, T., *et al*, Biol Cell. 2000 92(1):5-25), maintenance of tissue integrity (Eckes, B., *et al*, J Cell Sci. 2000 113(Pt 13):2455-2462;

10 Buckwalter, J.A., *et al*, Instr Course Lect. 2000 49:481-9; Frenette, P.S., *et al*, J Exp Med. 2000 191(8):1413-22; Delmas, V., *et al*, Dev Biol. 1999 216(2):491-506; Humphries, M.J., *et al*, Trends Pharmacol Sci. 2000 21(1):29-32; Miosge, N., *et al*, Lab Invest. 1999 79(12):1591-9; Nagaoka T, *et al*. Am J Pathol 2000 Jul 157:1 237-47; Nwariaku FE, *et al*. J Trauma 1995 39(2): 285-8; Zhu X, *et al*. Zhonghua Zheng Xing Shao Shang Wai Ke Za Zhi

15 1999 15(1): 53-5), leukocyte extravasation/inflammation (Lim, L.H., *et al*. Am J Respir Cell Mol Biol. 2000 22(6):693-701; Johnston, B., *et al*, Microcirculation. 2000 7(2):109-18; Mertens, A.V., *et al*, Clin Exp Allergy. 1993 23(10):868-73; Chcialowski, A., *et al*, Pol Merkuriusz Lek. 2000 7(43):13-7; Rojas, A.I., *et al*, Crit Rev Oral Biol Med. 1999 10(3):337-58; Marinova-Mutafchieva, L., *et al*, Arthritis Rheum. 2000 43(3):638-44; Vijayan, K.V., *et al*,

20 *et al*, J Clin Invest. 2000 105(6):793-802; Currie, A.J., *et al*, J Immunol. 2000 164(7):3878-86; Rowin, M.E., *et al*, Inflammation. 2000 24(2):157-73; Johnston, B., *et al*, J Immunol. 2000 164(6):3337-44; Gerst, J.L., *et al*, J Neurosci Res. 2000 59(5):680-4; Kagawa, T.F., *et al*, Proc Natl Acad Sci U S A. 2000 97(5):2235-40; Hillan, K.J., *et al*, Liver. 1999 19(6):509-18; Panes, J., 1999 22(10):514-24; Arao, T., *et al*, J Clin Endocrinol Metab. 2000 85(1):382-9;

25 Souza, H.S., *et al*, Gut. 1999 45(6):856-63; Grunstein, M.M., *et al*, Am J Physiol Lung Cell Mol Physiol. 2000 278(6):L1154-63; Mertens, A.V., *et al*, Clin Exp Allergy. 1993 23(10):868-73; Berends, C., *et al*, Clin Exp Allergy. 1993 23(11):926-33; Fernvik, E., *et al*, Inflammation. 2000 24(1):73-87; Bocchino, V., *et al*, J Allergy Clin Immunol. 2000 105(1 Pt 1):65-70; Jones SC, *et al*, Gut 1995 36(5):724-30; Liu CM, *et al*, Ann Allergy Asthma

30 Immunol 1998 81(2):176-80; McMurray RW Semin Arthritis Rheum 1996 25(4):215-33; Takahashi H, *et al* Eur J Immunol 1992 22(11): 2879-85; Carlos T, *et al* J Heart Lung Transplant 1992 11(6): 1103-8; Fabrega E, *et al*, Transplantation 2000 69(4): 569-73; Zohrens G, *et al*, Hepatology 1993 18(4): 798-802; Montefort S, *et al*. Am J Respir Crit Care

- Med 1994 149(5): 1149-52), oncogenesis (Orr, F.W., *et al.*, Cancer. 2000 88(S12):2912-2918; Zeller, W., *et al.*, J Hematother Stem Cell Res. 1999 8(5):539-46; Okada, T., *et al.*, Clin Exp Metastasis. 1999 17(7):623-9; Mateo, V., *et al.*, Nat Med. 1999 5(11):1277-84; Yamaguchi, K., *et al.*, J Exp Clin Cancer Res. 2000 19(1):113-20; Maeshima, Y., *et al.*, J Biol
- 5 Chem. 2000 275(28):21340-8; Van Waes, C., *et al.*, Int J Oncol. 2000 16(6):1189-95; Damiano, J.S., *et al.*, Leuk Lymphoma. 2000 38(1-2):71-81; Seftor, R.E., *et al.*, Cancer Metastasis Rev. 1999 18(3):359-75; Shaw, L.M., J Mammary Gland Biol Neoplasia. 1999 4(4):367-76; Weyant, M.J., *et al.*, Clin Cancer Res. 2000 6(3):949-56), angiogenesis (Koch AE, *et al* Nature 1995 376 (6540): 517-9; Wagener C & Ergun S. Exp Cell Res 2000 261(1):
- 10 19-24; Ergun S, *et al.* Mol Cell 2000 5(2): 311-20), bone resorption (Hartman GD, & Duggan ME. Expert Opin Investig Drugs 2000 9(6): 1281-91; Tanaka Y, *et al.* J Bone Miner Res 1995 10(10): 1462-9; Lark MW, *et al.* J Pharmacol Exp Ther 1999 291(2): 612-7; Raynal C, *et al.* Endocrinology 1996 137(6):2347-54; Ilvesaro JM, *et al.* Exp Cell Res 1998 242(1): 75-83), neurological dysfunction (Ossege LM, *et al.* Int Immunopharmacol 2001 1:1085-100;
- 15 Bitsch A, *et al.* Stroke 1998 29:2129-35; Iadecola C & Alexander M. Curr Opin Neurol 2001 14:89-94; Becker K, *et al* Stroke 2001 32(1): 206-11; Relton JK, *et al* Stroke 2001 32(1): 199-205; Hamada Y, *et al* J Neurochem 1996 66:1525-31), thrombogenesis (Wang, Y.G., *et al.*, J Physiol (Lond). 2000 526(Pt 1):57-68; Matsuno, H., *et al.*, Nippon Yakurigaku Zasshi. 2000 115(3):143-50; Eliceiri, B.P., *et al.*, Cancer J Sci Am. 2000 6(Suppl 3):S245-9; von
- 20 Beckerath, N., *et al.*, Blood. 2000 95(11):3297-301; Topol, E.J., *et al.*, Am Heart J. 2000 139(6):927-33; Kroll, H., *et al.*, Thromb Haemost. 2000 83(3):392-6), and invasion/adherence of bacterial pathogens to the host cell (Dersch P, *et al.* EMBO J 1999 18(5): 1199-1213).

The detailed characterisation of the structure and function of several immunoglobulin-domain containing cell surface recognition molecule families has led to active programs by

25 a number of pharmaceutical companies to develop modulators for use in the treatment of diseases involving inflammation, oncology, neurology, immunology and cardiovascular function. Immunoglobulin domain containing cell surface recognition molecules are involved in virtually every aspect of biology from embryogenesis to apoptosis. They are essential to the structural integrity and homeostatic functioning of most tissues. It is therefore

30 not surprising that defects in immunoglobulin domain containing cell surface recognition molecules cause disease and that many diseases involve modulation of immunoglobulin

domain containing cell surface recognition molecule function. The members of this family are described below in Table 1.

The Immunoglobulin domain containing cell surface recognition molecule family in fact contains several distinct families. Of these families, some are of particular pharmaceutical interest due to small molecule tractability. They include:

1. The immunoglobulin adhesion molecules represent the counter receptors for the integrins and includes the intracellular adhesion molecules (ICAMs) and vascular cell adhesion molecules (VCAMs). Members are composed of variable numbers of globular, immunoglobulin-like, extracellular domains. Some members of the family, for example, PECAM-1 (CD31) and NCAM, mediate homotypic adhesion. Some members of the family, for example ICAM-1 and VCAM-1, mediate adhesion via interactions with integrins.
2. Cell surface growth factor receptors. Growth factors are extracellular and in order to exert a biological effect they interact with specific, high affinity receptors located on the plasma membranes of target cells. The molecular characterisation of a variety of different growth factor receptors revealed that they fall into defined families; the tyrosine kinase receptors, G-protein associated seven transmembrane receptors, and the serine/threonine kinase receptors. The tyrosine kinase receptors are characterised by an extracellular domain, a transmembrane domain, and an intracellular domain which possess tyrosine kinase activity. VEGFR, PDGFR, FGFR, CSF-1R and c-KIT are examples of tyrosine kinase growth factor receptors which also contain immunoglobulin domains in the extracellular portion. Dys-regulation of growth factor function results in many different disease phenotypes, including, but not exclusive to oncology (Bartucci M *et al*, (2001) Cancer Res. Sep 15;61(18):6747-54, Dias S *et al.*, (2001) Proc Natl Acad Sci U S A. Sep 11;98(19):10857-62, Djavan B *et al.*, (2001) World J Urol. 19(4):225-33), inflammation (Fiocchi C. (2001) J Clin Invest. Aug;108(4):523-6, Hodge S *et al.*, (2001) Respiriology. Sep;6(3):205-211, Fenwick SA *et al.*, (2001) J Anat. Sep;199(Pt 3):231-40), neurological (Cooper JD *et al.*, (2001) Proc Natl Acad Sci U S A 98(18):10439-44, Fahnstock M *et al*, (2001) Mol Cell Neurosci 18(2):210-20), and metabolism (Vickers MH *et al.*, (2001) Endocrinology. 142(9):3964-73).

**Table 1: Immunoglobulin domain-containing cell surface recognition molecules**

<i>Receptor</i>	<i>Ligand</i>	<i>Distribution</i>
ICAM-1 5 Ig domains	LFA-1 (CD11a/CD18) Mac-1 (CD11b/CD18), CD43	Widespread, endothelial cells, fibroblasts, epithelium, monocytes, lymphocytes, dendritic cells, chondrocytes.
ICAM-2 2 Ig domains	LFA-1 (CD11b)	endothelial cells (high): lymphocytes, monocytes, basophils, platelets (low).
ICAM-3 5 Ig domains	LFA-1 ( $\alpha$ d/CD18)	Lymphocytes, monocytes, neutrophils, eosinophils, basophils.
VCAM-1 6 or 7 Ig domains	$\alpha$ 4 $\beta$ 1, $\alpha$ 4 $\beta$ 7	Endothelial cells, monocytes, fibroblasts, dendritic cells, bone marrow stromal cells, myoblasts.
LFA-3 6 Ig domains	CD2	Endothelial cells, leukocytes, epithelial cells
PECAM-1 (CD31)	CD31, heparin	Endothelial cells (at EC-EC junctions), T cell subsets, platelets, neutrophils, eosinophils, monocytes, smooth muscle cells, bone marrow stem cells.
NCAM	NCAM, heparin SO <sub>4</sub>	Neural cells, muscle
MAdCAM-1 4 Ig domains	$\alpha$ 4 $\beta$ 7, L-selectin	Peyer's patch, mesenteric lymph nodes, mucosal endothelial cells, spleen.
CD2	CD58, CD59, CD48	T lymphocytes
VEGFR	VEGF	Widespread, retina, umbilical vein, adrenal, NT2 neuronal precursor cells
FGFR	FGF	Widespread, brain, colon, ovary
KIT	Stem Cell Factor, MGF	Widespread, foetus, melanocytes, gall bladder, cerebellum, gastric epithelium (low)
PDGFR	PDGF	Widespread, breast, placenta, fibroblast, lung, ovary, skin, heart
CSF-1R	CSF	Widespread, placenta, liver, multiple sclerosis lesions, spleen, lung, breast.

Immunoglobulin domain-containing cell surface recognition molecules have thus been shown to play a role in diverse physiological functions, many of which can play a role in disease processes. Alteration of their activity is a means to alter the disease phenotype and as such identification of novel Immunoglobulin domain-containing cell surface recognition

molecules is highly relevant as they may play a role in many diseases, particularly immunology, inflammatory disease, oncology, cardiovascular disease, central nervous system disorders and infection.

## THE INVENTION

- 5 The invention is based on the discovery that the INSP052 and INSP055 proteins function as immunoglobulin domain-containing cell surface recognition molecules, and more particularly, as cytokine antagonists. Examples of immunoglobulin domain-containing cell surface recognition molecules are listed in Table 1.

In one embodiment of the first aspect of the invention, there is provided a polypeptide  
10 which:

- (i) comprises or consists of the amino acid sequence as recited in SEQ ID NO:2, SEQ ID NO:4, SEQ ID NO: 6, SEQ ID NO:8, SEQ ID NO:10, SEQ ID NO:12, SEQ ID NO:14, SEQ ID NO:16, SEQ ID NO:20, SEQ ID NO:22, SEQ ID NO:24, or SEQ ID NO:26;
- 15 (ii) is a fragment thereof having the activity of a polypeptide according to (i), or having an antigenic determinant in common with a polypeptide according to (i); or
- (iii) is a functional equivalent of (i) or (ii).

By “the activity of a polypeptide according to (i)”, we refer to immunoglobulin domain-containing cell surface recognition molecule activity. By immunoglobulin domain-  
20 containing cell surface recognition molecule activity we refer to polypeptides that comprise amino acid sequence or structural features that can be identified as conserved features within the immunoglobulin domain-containing cell surface recognition molecule family.

Included within this definition is activity as a cytokine antagonist. By “cytokine  
25 antagonist” is meant that the polypeptide, fragment or functional equivalent inhibits the activity of at least one cytokine. Preferably, the cytokine antagonists of the invention may inhibit cytokine activity by inhibiting cytokine expression and/or secretion. Cytokine antagonists that inhibit cytokine expression by other mechanisms, for example by binding to a cytokine or to a cytokine receptor, are also included in the invention. Preferably, the  
30 cytokine antagonists of the invention are able to inhibit the activity of more than one

cytokine.

Preferably, the cytokine antagonists of the invention have immunomodulatory activity. By “immunomodulatory activity” is meant any activity detected *in vitro* or *in vivo* that affects the immune response. Examples of immunomodulatory activities includes  
5 immunosuppressive activities, anti-inflammatory activities, pro-apoptotic activities, anti-apoptotic activities and anti-tumoral activities.

Cytokines which may be inhibited by the cytokine antagonists of the invention include: TGF-alpha; EGF; members of the four alpha-helical bundle family of cytokine (such as IL-2, IL-3, IL-4, IL-5, IL-6, IL-7, IL-9, IL-13, G-CSF, GM-CSF, CNTF, OSM, EPO, IL-10,  
10 IFN-alpha, IFN-beta, IFN-gamma and M-CSF); members of the cysteine knot family of cytokines (such as NGF, TGF-beta, PDGF and VEGF); chemokines (such as IL-8, MIP-1-alpha, MIP-1-beta, MIP-2, PF-4, PBP, I-309/TCA-3, MCP-1, MCP-2, MCP3 and IP-10), members of the TNF family of cytokines (such as TNF-alpha, TNF-beta and LT-beta); and members of the beta-trefoil family of cytokines including FGF-alpha, FGF-beta IL-1-  
15 alpha, IL-1-beta and IL-1ra). Preferred cytokine antagonists of the invention inhibit the activity of TNF-alpha, IL-4 and/or IL-2.

Cytokines form an heterogeneous family of secreted polypeptides, of relatively low molecular weight, acting as regulators of cellular reactions to various kind of stimuli, in particular those related to inflammatory and immune reactions but also those related to cell  
20 proliferation, repair, cell-cell interactions, and differentiation.

Cytokines are mainly represented by non-enzymatic glycoproteins that have been historically classified into several groups based on criteria such as sequence homology, structural elements, expressing cells, and/or binding activity. Examples of such families of sequences are Interleukins, Lymphokines, Monokines, Inteferons, but many other  
25 sequences have been characterized as having cytokine activities in the recent years (such as some growth factors or chemokines) making difficult to provide an exhaustive classification (Haddad JJ, 2002, Biochem Biophys Res Commun, 297:700-13).

Cytokines are mostly produced by monocytes, macrophages and lymphocytes, but also by other cell types (such as leukocytes, osteoblasts, smooth muscle cells, epithelial cells,  
30 neuronal cells, endothelial cells, or fibroblasts), but they are not normally produced in a constitutive manner. Cytokines are generally secreted by immune cells in response to an



offending agent (e.g. bacteria, virus, or other pathogens) that can stimulate their *de novo* expression and secretion from cells with the consequence of altering either their own functions (autocrine / intracrine effects) or those of adjacent cells and the local microenvironment (paracrine / juxtacrine effects).

- 5 Cytokines act on the target cell via receptors that trigger various cell signaling pathways. (Ishihara K and Hirano T, 2002, Biochim Biophys Acta, 1592: 281-296). Typically, the actions of cytokines are often pleiotropic (one cytokine may elicit several physiological effects), redundant (different cytokines may be responsible for a similar physiological effect), and may affect diverse and overlapping target cell populations.
- 10 The observed physiological effects of cytokines are due to fact that, in association to an inflammatory response leading to the mobilization and aggregation of cells, cytokines can induce (or suppress) the production of many proteins in a coordinate manner, including that of other cytokines and/or of cytokine receptors. Thus, many physiological responses (both under physiological and pathological conditions) are the result of inter-connected,
- 15 redundant network of synergistic or antagonistic interactions amongst cytokines.

The cloning and biological analyses of cytokines and of their receptors have led to a general understanding of molecular basis behind their pleiotropism and redundancy. This property can be often ascribed to the composition of cytokine receptor complexes that include a signal-transducing receptor subunit that is used by all members of a cytokine

20 family and a binding subunit that is specific for each cytokine. Thus, the cytokine-induced signalling cascade represents a mechanism having a final outcome for a particular cell or tissue that is determined by a number of different messages received concurrently at the cell surface.

The details of the functioning of the cytokine network are not yet fully understood, but it is

25 clear that cytokines are important mediators and are implicated in the pathogenesis of numerous diseases, directly or indirectly related to both innate and adaptive immune responses. In particular, main patho-physiological effects of cytokines result from their excessive or inappropriately localized production, inducing an inflammatory state negatively affecting the state of a patient. Therefore, it is a generally acknowledged that

30 any mechanism effectively inhibiting one or more cytokines, in particular proinflammatory cytokines, may have a positive effect in the treatment of human diseases by controlling the adverse cascade of cellular events associated to inappropriate or prolonged production of

particular cytokines.

At this time, a wide range of strategies and compounds has been disclosed in the literature regarding technologies for generating and/or administering antagonists of cytokines blocking their proinflammatory activities. A non-exhaustive list of these technologies includes soluble variants of the human cytokine receptors, cytokine-specific antibodies, viral proteins binding cytokines, small molecules inhibiting cytokine production. These immunomodulating molecules can target inefficient or misdirected immune responses. However, there are relatively few cytokine antagonists available for the use in the treatment of human diseases. The potential of alternative compounds for pharmacological intervention in cytokine-mediated inflammatory processes by modulating extracellular or intracellular signaling pathways has not been thoroughly explored by drug discovery programs (Stevceva L, 2002, Curr Med Chem., 9: 2201-7; Inagaki-Ohara K et al., 2003, Curr Opin Pharmacol., 3: 435-42).

Evidence is presented in the Examples section below that the extracellular domain of INSP052 (also referred to herein as INSP052EC) downregulates TNF-alpha, IL-4 and IL-2 secretion *in vitro* in a Concanavalin A (ConA) stimulated human peripheral blood mononuclear cells (hPBMC) assay and in a similar assay using CD4+ T cells. In addition, delivery of INSP052EC cDNA in an *in vivo* model of fulminant hepatitis was found to decrease TNF-alpha and m-IL-6 levels in serum and had a significant effect on the reduction of transaminases measured in serum. This effect was confirmed by subcutaneous INSP052EC protein injections.

The decrease in aspartate aminotransferase (ASAT) and alanine aminotransferase (ALAT) levels noted might be due to both decreased TNF-alpha and IL-4 levels. TNF-alpha and IL-4 are important cytokines involved in liver damage induced after ConA injection. In this mouse model of liver hepatitis, TNF-alpha is mainly produced by hepatic macrophages, the so-called Kupfer cells, whereas IL-4 is produced by liver (natural killer T) NKT cells. Anti TNF-alpha antibodies have been shown to confer protection against disease (Seino et al. 2001, Annals of surgery 234, 681) and inhibition of IL-4 production by NKT cells was shown to be hepato-protective in T-cell mediated hepatitis in mouse (Ajuebor et al. 2003 J. Immunology 170, 5252-9).

Furthermore, in a model of LPS-induced cytokine release in mice, the potential of INSP052EC to down-regulate LPS-induced TNF alpha or IL-6 release was demonstrated.

Additionally, INSP052EC was tested on hapten-induced contact hypersensitivity (CHS), a murine model of inflammatory skin disease. We show that INSP052EC reduces ear swelling in a significant and dose-dependent manner, suggesting a decrease in leukocyte infiltration and of the consequent inflammation, so demonstrating that INSP052EC can be  
5 useful in treating T cell-mediated inflammation of the skin, such as in allergic contact dermatitis and psoriasis.

It is clearly shown herein that the isolated extracellular domain of INSP052 (INSP052EC) can be used (as such or as a variant or a fusion protein containing this protein sequence or the full length protein) for modulating cytokine activities, functioning in particular as an  
10 antagonist of cytokine secretion and/or expression, and may have a therapeutic role in diseases directly or indirectly related to both innate and adaptive immune responses. These results obtained with the extracellular domain of INSP052 allow us to infer that other variants of the INSP052 polypeptide, as well as the full length polypeptide sequence, are likely to share equivalent functions to those demonstrated. Accordingly, it is considered  
15 that INSP052, INSP052EC (SEQ ID NO.20 and SEQ ID NO.22) and related functionally equivalent proteins will be useful in treating auto-immune, viral or acute liver diseases as well as alcoholic liver failures. They are likely also to be effective in treating other inflammatory diseases.

The range of inhibiting activities shown by the tested INSP052EC-based molecule in  
20 different cell-based assays and animal models confirms that patho-physiological effects of cytokines resulting from their excessive or inappropriately localized production can be blocked by using this molecule. The control of cellular events associated with prolonged production of proinflammatory cytokines can be obtained by INSP052EC-based molecules, which therefore can be used for antagonizing abnormal inflammatory states  
25 associated, in particular, to autoimmune and inflammatory diseases affecting various tissues and organs (e.g. liver, skin, lungs, central nervous system), providing as well a new therapeutic opportunity for oncological, neurological, cardiovascular, and infectious disorders. Additional clinical applications for INSP052EC-based molecules can be identified by using cytokine assays showing the excessive expression and / or secretion of  
30 cytokines in samples obtained by patients affected by other diseases (Wong CK and Lam CW, Adv Clin Chem. 2003, 37:1-46; Whiteside TL, Biotechniques, 2002, Oct. Suppl:4-8, 10, 12-5), then justifying the therapeutic use of a cytokine antagonist as INSP052EC-

based molecules.

The polypeptide having the sequence recited in SEQ ID NO:2 is referred to hereafter as "the INSP052 exon 1 polypeptide". The polypeptide having the sequence recited in SEQ ID NO:4 is referred to hereafter as "the INSP052 exon 2 polypeptide". The polypeptide  
5 having the sequence recited in SEQ ID NO:6 is referred to hereafter as "the INSP052 exon 3 polypeptide". The polypeptide having the sequence recited in SEQ ID NO:8 is referred to hereafter as "the INSP052 exon 4 polypeptide". The polypeptide having the sequence recited in SEQ ID NO:10 is referred to hereafter as "the INSP052 exon 5 polypeptide". The polypeptide having the sequence recited in SEQ ID NO:12 is referred to hereafter as "the  
10 INSP052 exon 6 polypeptide". The polypeptide having the sequence recited in SEQ ID NO:14 is referred to hereafter as "the INSP052 exon 7 polypeptide". Combining SEQ ID NO:2, SEQ ID NO:4, SEQ ID NO:6, SEQ ID NO:8, SEQ ID NO:10, SEQ ID NO:12 and SEQ ID NO:14 produces the sequence recited in SEQ ID NO:16. The polypeptide having the sequence recited in SEQ ID NO:16 is referred to hereafter as the INSP052 polypeptide.  
15 The polypeptide having the sequence recited in SEQ ID NO:20 is the extracellular domain of INSP052. The polypeptide having the sequence recited in SEQ ID NO:22 is referred to hereafter as the extracellular domain of the mature INSP052 polypeptide. The polypeptide having the sequence recited in SEQ ID NO:24 is referred to hereafter as the mature INSP052 exon 2 polypeptide. The polypeptide having the sequence recited in SEQ ID  
20 NO:26 is referred to hereafter as the mature INSP052 polypeptide. The polypeptide having the sequence recited in SEQ ID NO:29 is referred to hereafter as the histidine-tagged, extracellular domain of mature INSP052. The polypeptide having the sequence recited in SEQ ID NO:30 is referred to hereafter as the Fc fusion of the extracellular domain of mature INSP052. The polypeptide having the sequence recited in SEQ ID NO:31 is  
25 referred to hereafter as the Ig domain containing fragment of INSP052 (INSP052Ig2).

The term "INSP052 exon polypeptides" as used herein includes polypeptides comprising or consisting of the polypeptide sequences set forth herein, including the INSP052 exon 1 polypeptide, the INSP052 exon 2 polypeptide, the INSP052 exon 3 polypeptide, the INSP052 exon 4 polypeptide, the INSP052 exon 5 polypeptide, the INSP052 exon 6  
30 polypeptide, the INSP052 exon 7 polypeptide, the INSP052 polypeptide, the extracellular domain of INSP052, the extracellular domain of mature INSP052, the INSP052 mature exon 2 polypeptide, the mature INSP052 polypeptide, the histidine-tagged, extracellular

domain of mature INSP052, the Fc fusion of the extracellular domain of mature INSP052 and the Ig domain containing fragment of INSP052.

In one embodiment, the polypeptide according to this embodiment consists of the amino acid sequence recited in SEQ ID NO:16 (the INSP052 polypeptide) or is a fragment of or  
5 functional equivalent thereof. In another embodiment, the polypeptide consists of the amino acid sequence recited in any one of SEQ ID NO:2, SEQ ID NO:4, SEQ ID NO: 6, SEQ ID NO:8, SEQ ID NO:10, SEQ ID NO:12, or SEQ ID NO:14, or is a variant thereof.

In a further embodiment of the first aspect of the invention there is provided a polypeptide which:

- 10 i) comprises or consists of the amino acid sequence as recited in SEQ ID NO:20 or SEQ ID NO:22;
- ii) is a fragment thereof having the activity of a polypeptide according to (i), or having an antigenic determinant in common with a polypeptide according to (i); or
- iii) is a functional equivalent of (i) or (ii).

15 The amino acid sequence recited in SEQ ID NO:20 represents the extracellular domain of INSP052 and corresponds to amino acids 1-240 of the full length protein (see the Examples section). SEQ ID NO:22 represents the extracellular domain of mature INSP052. See also Figure 7 for the extracellular domain of INSP052.

It is considered highly likely that the extracellular domain will fold correctly and show  
20 biological activity if additional residues C terminal and/or N terminal of these boundaries in the polypeptide sequence are included in the polypeptide fragment. For example, an additional 5, 10, 20, 30, 40, 50 or even 100 amino acid residues from the INSP052 polypeptide sequence, or from a homologous sequence, may be included at either or both the C terminal and/or N terminal of the boundaries of the receptor binding domain, without  
25 prejudicing the ability of the polypeptide fragment to fold correctly and exhibit biological activity. Extensions as large as 100 or 200 residues may be necessary due to the presence of large loops between secondary structural elements.

For truncated variants of the INSP052 extracellular domain, one or a few amino acid residues (for example, 2, 3, 4, 5, 10, 15, 20, 25, 30 or more) may be deleted at either or  
30 both the C terminus or the N terminus of the domain without prejudicing biological

activity.

A preferred truncated variant of the INSP052 extracellular domain is the Ig domain containing fragment of INSP052 (INSP052Ig2) having the sequence shown in SEQ ID NO:31. The invention provides a polypeptide which: (i) comprises or consists of the amino acid sequence as recited in SEQ ID NO:31; is a fragment thereof having the activity of a polypeptide according to (i), or having an antigenic determinant in common with a polypeptide according to (i); or is a functional equivalent of (i) or (ii).

As discussed below, the polypeptides of the invention may be provided in the form of a fusion protein or as "free-standing" protein. Accordingly, one embodiment of the invention provides a polypeptide which consists of the extracellular domain of INSP052. Another embodiment of the invention provides a polypeptide which consists of INSP052 (the full length protein or the extracellular domain thereof, including the mature version and truncated variants thereof) fused with at least one other polypeptide to form a fusion protein.

Accordingly, still further embodiments of the present invention include a polypeptide, which polypeptide comprises or consists of two sequences (a) and (b), wherein:

a) is an amino acid sequence at least 90% identical to:

- (i) the amino acid sequence as recited in SEQ ID NO:20, SEQ ID NO:22 or SEQ ID NO:31;
- (ii) is a fragment thereof having the activity of a polypeptide according to (i), or having an antigenic determinant in common with a polypeptide according to (i); or
- (iii) is a functional equivalent of (i) or (ii).; and

b) is an heterologous amino acid sequence chosen from the group of: a signal sequence, purification tag, the extracellular domain of a membrane-bound protein, a secreted protein, a starting Methionine, a linker region containing a recognition site for an endopeptidase, or the Fc region from an immunoglobulin molecule.

Such fusion proteins can be obtained by cloning a polynucleotide encoding a polypeptide comprising a sequence having at least 90% homology with any one of the INSP052 polypeptides described above over the length of the polypeptide, preferably at least 95% at least 97% at least 98% or at least 99% homology, in frame with the coding sequences for a

heterologous protein sequence.

The term "heterologous", when used herein, is intended to designate any polypeptide other than a human INSP052 polypeptide. Examples of heterologous sequences, that can be comprised in the fusion proteins either at the N- or C-terminus, include: extracellular  
5 domains of membrane-bound protein, immunoglobulin constant regions (Fc regions), multimerization domains, domains of extracellular proteins, signal sequences, export sequences, and sequences allowing purification by affinity chromatography.

Many of these heterologous sequences are commercially available in expression plasmids since these sequences are included in fusion proteins in order to provide additional  
10 properties without significantly impairing the specific biological activity of the protein fused to them (Terpe K, 2003, Appl Microbiol Biotechnol, 60:523-33).

Examples of such additional properties are a longer lasting half-life in body fluids, an easier purification procedure, an additional binding moiety, maturation by means of an endoproteolytic digestion, increased stability during recombinant production, or  
15 extracellular localization. This latter feature is of particular importance since it allows the polypeptides to be localized in the space where the isolation and purification of these polypeptides is facilitated.

Design of the moieties, ligands, and linkers, as well methods and strategies for the construction, purification, detection, maturation, and use of fusion proteins are widely  
20 discussed in the literature (Nilsson J et al., Protein Expr Purif, 11: 1-16, 1997; "Applications of chimeric genes and hybrid proteins" Methods Enzymol. Vol. 326-328, Academic Press, 2000).

If needed, the heterologous sequence can be eliminated by a proteolytic cleavage after purification of the protein or *in vivo*. This can be achieved, for example, by inserting a  
25 proteolytic cleavage site between the protein and the heterologous sequence, and exposing the fusion protein to the appropriate endo-/ exopeptidase. These features facilitate the production of fusion proteins and their use in the preparation of pharmaceutical compositions.

For example, the heterologous sequence can be linked to the protein by linker sequence  
30 containing a recognition site for an endopeptidase (such as a caspase) that can be used to detach the desired protein from the heterologous sequence either *in vivo* or *in vitro*.

Alternatively, if the protein to be expressed does not contain a start methionine (e.g. if it a mature sequence without the signal peptide), the heterologous sequence may be a start methionine to allow correct expression in the host cell. This additional amino acid may be eliminated subsequently by means of an exopeptidase, such as Methionine  
5 Aminopeptidase, according to methods disclosed in the literature (Van Valkenburgh HA and Kahn RA, *Methods Enzymol*, 344: 186-193, 2002; Ben-Bassat A, *BioProcess Technol*, 12:147-159, 1991).

The heterologous sequences to which the polypeptides of the invention may be fused may consist of sequences that facilitate the secretion of the protein, such as signal peptides and  
10 export signals (Rapoport TA et al., *Annu Rev Biochem*. 1996; 65:271-303).

Alternatively, the heterologous sequence in the fusion protein may enable easier purification of the protein. For example, the INSP052 polypeptide may be purified by means of a hexa-histidine peptide fused at the C-terminus of INSP052. An example of such a fusion polypeptides is presented in SEQ ID NO:29. This hexa-histidine peptide forms a  
15 so-called "histidine tag" which facilitates purification (Gentz *et al.* 1989, *Proc Natl Acad Sci USA*, 86:821-4). A "HA" tag, an epitope derived from the influenza hemagglutinin protein (Wilson *et al.* 1994, *Cell*, 37:767-78) or other affinity purification tags such as GST, FLAG or MBP may be used in place of the histidine tag.

The heterologous sequence of the fusion protein may provide a further functional activity.  
20 For example, the extracellular domain of INSP052 which has cytokine antagonist activity may be fused with a heterologous sequence which also has anti-inflammatory or, in general, immunomodulatory activity such as further cytokine antagonists, collagen II-binding agents (such as those disclosed in WO01/37861) and cytokines themselves (such as those disclosed in WO03/095488, WO03/014359 and WO03/035105).

25 The heterologous sequence may provide better stability, prolonging the half-life of a polypeptide of the invention and thereby improving its therapeutic activity. For example, the polypeptides may be fused to human serum albumin, or to other sequences that bind to circulating human serum albumin (see Chuang VT et al., *Pharm Res*. 2002; 19: 569-577; Graslund T et al., *Protein Expr Purif*. 1997, 9: 125-32; WO 01/77137). Alternatively, the  
30 additional sequence may help the targeting to specific localization, such as in the brain (WO 03/32913).



The heterologous sequence may improve stability by allowing the formation of multimers of the protein. Examples of heterologous sequences promoting multimerisation include domains isolated from proteins such as hCG (WO 97/30161), collagen X (WO 04/33486), C4BP (WO 04/20639), Erb proteins (WO 98/02540), or coiled coil peptides (WO 5 01/00814).

In a preferred embodiment, the polypeptide is fused to the constant region of an Ig molecule. An example of such a polypeptide is presented in SEQ ID NO:30. Preferably, the polypeptide is fused to a heavy chain region, like the CH2 and CH3 domains of human IgG1, for example. Other isoforms of Ig molecules are also suitable for the generation of 10 fusion proteins according to the present invention, such as isoforms IgG2 or IgG4, or other Ig classes, like IgM or IgA, for example. The constant region promotes stability by promoting multimerisation. Fusion proteins may be monomeric or multimeric, hetero- or homomultimeric.

Examples of strategies for generating fusion proteins comprising a protein and an 15 immunoglobulin fragment are disclosed in the literature (WO 91/08298; WO 96/08570; WO 93/22332; WO 04/085478; WO 01/03737, WO 02/66514).

For example, the nucleic acid sequence encoding the mature INSP052 extracellular domain can be cloned in an expression vector fused to a nucleic acid sequence encoding the original INSP052 signal sequence (or any other appropriate signal /export sequence) at its 20 5' end, and the nucleic acid sequence encoding the constant region of human immunoglobulin lambda heavy chain IgG1 (NCBI Acc. No. CAA75302; segment 246-477) at its 3'end. The resulting vector can be used to transform a CHO or HEK293 host cell line and the clones stably expressing and secreting the recombinant fusion protein having the INSP052 extracellular domain at the N-terminus and the IgG1 sequence at the 25 C-terminus can be selected. This clone then can be used for scaling up the production and for purifying the recombinant fusion protein from the culture medium. Alternatively, the position of the nucleic acid encoding the constant region of human immunoglobulin lambda heavy chain IgG1 and INSP052 extracellular domain can be inverted, and the resulting protein can be expressed and secreted using still the original signal sequence of 30 INSP052, or any other appropriate signal / export sequence.

It is also possible to generate heterodimers using this technology by coexpressing constructs encoding two different fusion proteins in the same cell (WO00/18932). For

example, a cell may express a first fusion protein comprising the INSP052 extracellular domain fused to an Fc domain and a second fusion protein comprising an Fc domain fused to a protein with different activity, such as a further cytokine antagonist, a collagen II-binding agent (such as those disclosed in WO01/37861) and or a cytokine (such as those disclosed in WO03/095488, WO03/014359 and WO03/035105).

When the fusion protein comprises an immunoglobulin region, the fusion may be direct, or via a short linker peptide which can be as short as 1 to 3 amino acid residues in length or longer, for example, 13 amino acid residues in length. Said linker may be a tripeptide of the sequence E-F-M (Glu-Phe-Met), for example, or a 13-amino acid linker sequence comprising Glu-Phe-Gly-Ala-Gly-Leu-Val-Leu-Gly-Gly-Gln-Phe-Met introduced between the sequence of the substances of the invention and the immunoglobulin sequence. The resulting fusion protein has improved properties, such as an extended residence time in body fluids (*i.e.* an increased half-life), increased specific activity, increased expression level, or the purification of the fusion protein is facilitated.

In a further preferred embodiment, at least one moiety is attached to one or more functional groups within the polypeptide of the invention which occur as one or more side chains on the amino acid residues. The moiety is preferably a stabilizing polymer that allows the formation of conjugates and complexes (Harris JM and Chess RB; Nat Rev Drug Discov, 2: 214-221, 2003; Greenwald RB et al., Adv Drug Deliv Rev, 55: 217-250, 2003; Pillai O and Panchagnula R, Cur Opin Chem Biol, 5: 447-451, 2001). The polymer may be produced following a site-directed modification of an appropriate residue, in an internal or terminal position. Amino acid residues within the polypeptide or fusion protein can be used for attachment, provided they have a side-chain amenable for polymer attachment (*i.e.*, the side chain of an amino acid bearing a functional group, *e.g.*, lysine, aspartic acid, glutamic acid, cysteine, histidine, etc.). Alternatively, a residue at these sites can be replaced with a different amino acid having a side chain amenable for polymer attachment.

For example, an additional cysteine allowing direct PEGylation can be added at the N- or C-terminus of the extracellular domain of INSP052. Alternatively, a cysteine may be included in the protein by the substitution of a residue, for example in correspondence of a glycosylation site. Moreover, the side chains of the genetically encoded amino acids can be chemically modified for polymer attachment, or unnatural amino acids with appropriate side chain functional groups can be employed. Polymers may also be attached to a

carbohydrate or other moiety that is attached to the side chain of the amino acid at the target position.

Polymers suitable for these purposes are non-toxic to biological systems. Such polymers may be hydrophobic or hydrophilic in nature, biodegradable, non-biodegradable, or a combination thereof. These polymers include natural polymers (such as collagen, gelatin, cellulose, hyaluronic acid), as well as synthetic polymers (such as polyesters, polyorthoesters, polyanhydrides). Examples of hydrophobic non-degradable polymers include polydimethyl siloxanes, polyurethanes, polytetrafluoroethylenes, polyethylenes, polyvinyl chlorides, and polymethyl methacrylates. Examples of hydrophilic non-degradable polymers include poly(2-hydroxyethyl methacrylate), polyvinyl alcohol, poly(N-vinyl pyrrolidone), polyalkylenes, polyacrylamide, and copolymers thereof. Preferred polymers comprise as a sequential repeat unit ethylene oxide, such as polyethylene glycol (PEG). The preferred method of attachment employs a combination of peptide synthesis and chemical ligation. Advantageously, the attachment of a water-soluble polymer will be through a biodegradable linker, especially at the amino-terminal region of a protein. Such modification acts to provide the protein in a precursor (or "pro-drug") form, that, upon degradation of the linker releases the protein without polymer modification.

In a second aspect, the invention provides a purified nucleic acid molecule which encodes a polypeptide of the first aspect of the invention.

Preferably, the purified nucleic acid molecule comprises or consists of the nucleic acid sequence as recited in SEQ ID NO:1 (encoding the INSP052 exon 1 polypeptide), SEQ ID NO:3 (encoding the INSP052 exon 2 polypeptide), SEQ ID NO:5 (encoding the INSP052 exon 3 polypeptide), SEQ ID NO:7 (encoding the INSP052 exon 4 polypeptide), SEQ ID NO:9 (encoding the INSP052 exon 5 polypeptide), SEQ ID NO:11 (encoding the INSP052 exon 6 polypeptide), SEQ ID NO:13 (encoding the INSP052 exon 7 polypeptide), SEQ ID NO:15 (encoding the INSP052 polypeptide), SEQ ID NO:17 (encoding the INSP055 polypeptide), SEQ ID NO:20 (encoding the extracellular domain of the INSP052 polypeptide), SEQ ID NO:22 (encoding the extracellular domain of the INSP052 mature polypeptide), SEQ ID NO:24 (encoding the mature INSP052 exon 2 polypeptide), SEQ ID NO:26 (encoding the mature INSP052 polypeptide) or is a redundant equivalent or fragment of any one of these sequences.

Combining the sequences recited in SEQ ID NO:1, SEQ ID NO:3, SEQ ID NO:5, SEQ ID

NO:7, SEQ ID NO:9, SEQ ID NO:11 and SEQ ID NO:13 produces the sequence recited in SEQ ID NO:15.

Combining the sequences recited in SEQ ID NO:23, SEQ ID NO:5, SEQ ID NO:7, SEQ ID NO:9, SEQ ID NO:11 and SEQ ID NO:13 produces the sequence recited in SEQ ID  
5 NO:25.

In one embodiment of the second aspect of the invention there is provided a nucleic acid molecule which encodes a polypeptide which comprises or consists of the extracellular domain of INSP052 (SEQ ID NO:20). Preferably, the nucleic acid molecule comprises or consists of the nucleic acid sequence set forth in SEQ ID NO:19. This is also set out in  
10 Figure 7 of co-pending patent application WO03/093316, although these sequences include histidine residues added to the C terminal.

In one embodiment of the second aspect of the invention there is provided a nucleic acid molecule which encodes a polypeptide which comprises or consists of the extracellular domain of mature INSP052 (SEQ ID NO:22). Preferably, the nucleic acid molecule  
15 comprises or consists of the nucleic acid sequence set forth in SEQ ID NO:21. This is also set out in Figure 7 of co-pending patent application WO03/093316, although these sequences include histidine residues added to the C terminal.

In one embodiment of the second aspect of the invention there is provided a nucleic acid molecule which encodes a polypeptide which comprises or consists of the variant of the  
20 extracellular domain of mature INSP052 which is the Ig-domain containing fragment of INSP052 (SEQ ID NO:31).

In a third aspect, the invention provides a purified nucleic acid molecule which hybridizes under high stringency conditions with a nucleic acid molecule of the second aspect of the invention.

25 In a fourth aspect, the invention provides a vector, such as an expression vector, that contains a nucleic acid molecule of the second or third aspect of the invention.

In a fifth aspect, the invention provides a host cell transformed with a vector of the fourth aspect of the invention.

In a sixth aspect, the invention provides a ligand which binds specifically to, and which  
30 preferably inhibits the activity of a polypeptide of the first aspect of the invention. The

skilled person will understand that the term "ligand" encompasses any moiety that binds specifically to the polypeptide of the first aspect of the invention including, for example, antibodies and orphan receptors.

By "the activity of a polypeptide of the invention" and similar expressions, we refer to activity characteristic of immunoglobulin domain-containing cell surface recognition molecules. In particular, included within this definition is activity as a cytokine antagonist as defined above, particularly as an antagonist of cytokine expression and/or secretion, particularly with respect to TNF-alpha, IL-4 and IL-2. Preferably, the cytokine antagonists of the invention have immunomodulatory activity. An example of a utility of the polypeptides of the invention in this respect is in the treatment of T cell-mediated inflammation of the skin, such as in allergic contact dermatitis and psoriasis.

Methods for identification of ligands according to the sixth aspect of the invention are described in detail below. In particular, the invention provides a method for the identification of a compound that is a ligand that binds specifically to the polypeptides of SEQ ID NO: 20 or SEQ ID NO: 22, comprising contacting a polypeptide according to the first aspect of the invention with one or more compounds suspected of possessing binding affinity for said polypeptide and selecting a compound that binds specifically to said polypeptide. Ligands of the polypeptides of the invention identified by such methods may be used to identify further cytokine antagonists. For example, screening methods may be contacted to identify compounds that bind to such ligands, such as antibodies, which may also act as cytokine antagonists.

In a seventh aspect, the invention provides a compound that is effective to alter the expression of a natural gene which encodes a polypeptide of the first aspect of the invention or to regulate the activity of a polypeptide of the first aspect of the invention.

A compound of the seventh aspect of the invention may either increase (agonise) or decrease (antagonise) the level of expression of the gene or the activity of the polypeptide.

Importantly, the identification of the function of the INSP052 and INSP055 polypeptides allows for the design of screening methods capable of identifying compounds that are effective in the treatment and/or diagnosis of disease. Ligands and compounds according to the sixth and seventh aspects of the invention may be identified using such methods. These methods are included as aspects of the present invention.

Evidence is presented in the Examples section below that the extracellular domain of INSP052 may be used to prevent or treat inflammatory diseases, auto-immune diseases, skin disease, liver disease and liver failure. Accordingly, the provision of a compound according to the seventh aspect of the invention which mimics extracellular domain of INSP052 conformationally, or is an agonist of the extracellular domain of INSP052 is particularly preferred since such a compound may find utility in the prevention or treatment of an inflammatory disease, an auto-immune disease, liver disease or liver failure as described above.

In an eighth aspect, the invention provides a polypeptide of the first aspect of the invention, or a nucleic acid molecule of the second or third aspect of the invention, or a vector of the fourth aspect of the invention, or a host cell of the fifth aspect, or a ligand of the sixth aspect of the invention, or a compound of the seventh aspect of the invention, for use in therapy or diagnosis, preferably in relation to inflammatory diseases, auto-immune diseases, skin disease, liver disease (including viral or acute liver disease) and liver failure (including alcoholic liver failure).

The moieties of the first, second, third, fourth, fifth and sixth aspects of the invention may also be used in the manufacture of a medicament for the prevention or treatment of diseases including, but not limited to, cell proliferative disorders, autoimmune/inflammatory disorders, cardiovascular disorders, neurological and psychiatric disorders, developmental disorders, genetic disorders, metabolic disorders, infections and other pathological conditions.

These diseases preferably include neoplasm, cancer, brain tumour, glioma, bone tumor, lung tumor, breast tumour, prostate tumour, colon tumour, hemangioma, myeloproliferative disorder, leukemia, hematological disease, neutropenia, thrombocytopenia, angiogenesis disorders, dermatological disease, ageing, wounds, burns, fibrosis, cardiovascular disease, restenosis, heart disease, peripheral vascular disease, coronary artery disease, oedema, thromboembolism, dysmenorrhea, endometriosis, pre-eclampsia, lung disease, COPD, asthma bone disease, renal disease, glomerulonephritis, liver disease, Crohn's disease, gastritis, ulcerative colitis, ulcer, immune disorder, autoimmune disease, arthritis, rheumatoid arthritis, psoriasis, epidermolysis bullosa, systemic lupus erythematosus, ankylosing spondylitis, Lyme disease, multiple sclerosis, neurodegeneration, stroke, brain/spinal cord injury, Alzheimer's disease, Parkinson's

disease, motor neurone disease, neuromuscular disease, HIV, AIDS, cytomegalovirus infection, fungal infection, ocular disorder, macular degeneration, glaucoma, diabetic retinopathy, ocular hypertension and other conditions in which immunoglobulin domain containing cell surface recognition molecules, particularly cytokine antagonists, are implicated.

It is particularly preferred that the moieties of the first, second, third, fourth, fifth and sixth aspects of the invention are used in the manufacture of a medicament for the treatment of inflammatory diseases, auto-immune diseases, skin disease, liver disease (including viral or acute liver disease) and liver failure (including alcoholic liver failure).

10 The moieties of the first, second, third, fourth, fifth and sixth aspects of the invention may be used in combination with other therapeutic agents to treat the diseases listed above. In particular, the polypeptides of the invention (including fusion proteins) which have cytokine antagonist activity may be used in combination with a further therapeutic agent.

The invention therefore provides the use of i) a moiety of the first, second, third, fourth, 15 fifth and sixth aspects of the invention, in particular a polypeptide or a fusion protein comprising the extracellular domain of INSP052 and ii) a further therapeutic agent, in the manufacture of a medicament for treating diseases or conditions in which cytokines, preferably TNF, IL-2 and/or IL-4, are implicated. Preferably, the disease or condition is selected from inflammatory diseases, auto-immune diseases, skin disease, liver disease 20 (including viral or acute liver disease) and liver failure (including alcoholic liver failure).

The further therapeutic agent may antagonise the same cytokine as the polypeptides of the invention or may antagonise another moiety in the physiological pathway causing the disease or alleviate symptoms caused by the disease.

Preferably, the therapeutic agent is a cytokine antagonist (preferably an antagonist of TNF, 25 IL-2 and/or IL-4), or an anti-inflammatory agent.

Examples of cytokine antagonists which may be used as further therapeutic agents include TNF-alpha antagonists such as etanercept, infliximab TNF alpha converting enzyme inhibitor (TACE inhibitor), and leflunomide used in the treatment of rheumatoid arthritis; and IL-2 antagonists such as basilimab and daclizumab used in the prevention of graft 30 rejection. The further therapeutic agent may also be an anti-inflammatory agent such as a

steroid or non-steroidal anti-inflammatory or may be another agent already used in the treatment of auto-immune disease, skin disease, liver disease or liver failure.

The additional therapeutic agent may be administered to the patient at the same time as the moiety of the first, second, third, fourth, fifth and sixth aspects of the invention, i.e. as a mixture. Alternatively, the moiety of the first, second, third, fourth, fifth and sixth aspects of the invention may be administered to a patient who has already received the therapeutic agent or the therapeutic agent may be administered to a patient who has already received the moiety of the first, second, third, fourth, fifth and sixth aspects of the invention. The combination may thus be for simultaneous, sequential or separate administration.

- 5 In a ninth aspect, the invention provides a method of diagnosing a disease in a patient, comprising assessing the level of expression of a natural gene encoding a polypeptide of the first aspect of the invention or the activity of a polypeptide of the first aspect of the invention in tissue from said patient and comparing said level of expression or activity to a control level, wherein a level that is different to said control level is indicative of disease.
- 10 Such a method will preferably be carried out *in vitro*.

Similar methods may be used for monitoring the therapeutic treatment of disease in a patient, wherein altering the level of expression or activity of a polypeptide or nucleic acid molecule over the period of time towards a control level is indicative of regression of disease.

- 20 A preferred method for detecting polypeptides of the first aspect of the invention comprises the steps of: (a) contacting a ligand, such as an antibody, of the sixth aspect of the invention with a biological sample under conditions suitable for the formation of a ligand-polypeptide complex; and (b) detecting said complex.

- A number of different methods according to the ninth aspect of the invention exist, as the skilled reader will be aware, such as methods of nucleic acid hybridization with short probes, point mutation analysis, polymerase chain reaction (PCR) amplification and methods using antibodies to detect aberrant protein levels. Similar methods may be used on a short or long term basis to allow therapeutic treatment of a disease to be monitored in a patient. The invention also provides kits that are useful in these methods for diagnosing disease.
- 25
- 30

Preferably, the disease diagnosed by a method of the ninth aspect of the invention is a



disease in which immunoglobulin domain-containing cell surface recognition molecules are implicated, as described above.

A preferred disease diagnosed by a method of the ninth aspect of the invention is an inflammatory disease, auto-immune disease, skin disease, liver disease (including viral or  
5 acute liver disease) or liver failure (including alcoholic liver failure).

In a tenth aspect, the invention provides for the use of the polypeptides of the first aspect of the invention as immunoglobulin domain-containing cell surface recognition molecules. The importance of the Ig domain in cell surface receptors is described in Lokker NA et al., "Functional importance of platelet-derived growth factor (PDGF) receptor extracellular  
10 immunoglobulin-like domains. Identification of PDGF binding site and neutralizing monoclonal antibodies," *J Biol Chem* 1997 Dec 26;272(52):33037-44.

The invention provides for the use of the polypeptides of the first aspect of the invention as cytokine antagonists, as described above, particularly antagonists of TNF-alpha, IL-4 and IL-2 secretion. In this respect, the polypeptides of the invention may act as antagonists of  
15 cytokines, by lowering levels of cytokine expression, levels of cytokine activity, levels of cytokine secretion and so on.

The invention also provides for the use of a nucleic acid molecule according to the second or third aspects of the invention to express a protein that possesses immunoglobulin domain-containing cell surface recognition molecule activity. The invention also provides  
20 a method for effecting immunoglobulin domain-containing cell surface recognition molecule activity, said method utilising a polypeptide of the first aspect of the invention.

In an eleventh aspect, the invention provides a pharmaceutical composition comprising a polypeptide of the first aspect of the invention, or a nucleic acid molecule of the second or third aspect of the invention, or a vector of the fourth aspect of the invention, or a host cell  
25 of the fifth aspect of the invention, or a ligand of the sixth aspect of the invention, or a compound of the seventh aspect of the invention, in conjunction with a pharmaceutically-acceptable carrier.

According to one embodiment of the eleventh aspect of the invention, the pharmaceutical composition of the invention may additionally comprise a further therapeutic agent. The  
30 further therapeutic agent may antagonise the same cytokine as the polypeptides of the

invention or may antagonise another moiety in the physiological pathway causing the disease or alleviate symptoms caused by the disease.

Preferably, the therapeutic agent is a cytokine antagonist (preferably an antagonist of TNF, IL-2 and/or IL-4), or an anti-inflammatory agent.

- 5 Examples of cytokine antagonists which may be used as further therapeutic agents include TNF-alpha antagonists such as etanercept, infliximab TNF alpha converting enzyme inhibitor (TACE inhibitor), and leflunomide used in the treatment of rheumatoid arthritis; and IL-2 antagonists such as basilimab and daclizumab used in the prevention of graft rejection. The further therapeutic agent may also be an anti-inflammatory agent such as a  
10 steroid or non-steroidal anti-inflammatory or may be another agent already used in the treatment of auto-immune disease, skin disease, liver disease or liver failure.

- In a twelfth aspect, the present invention provides a polypeptide of the first aspect of the invention, or a nucleic acid molecule of the second or third aspect of the invention, or a vector of the fourth aspect of the invention, or a host cell of the fifth aspect of the  
15 invention, or a ligand of the sixth aspect of the invention, or a compound of the seventh aspect of the invention, for use in therapy or diagnosis. These molecules may also be used in the manufacture of a medicament for the treatment of diseases including, but not limited to, cell proliferative disorders, autoimmune/inflammatory disorders, cardiovascular disorders, neurological and psychiatric disorders, developmental disorders, genetic  
20 disorders, metabolic disorders, infections and other pathological conditions. These diseases preferably include neoplasm, cancer, brain tumour, glioma, bone tumor, lung tumor, breast tumour, prostate tumour, colon tumour, hemangioma, myeloproliferative disorder, leukemia, hematological disease, neutropenia, thrombocytopenia, angiogenesis disorders, dermatological disease, ageing, wounds, burns, fibrosis, cardiovascular disease,  
25 restenosis, heart disease, peripheral vascular disease, coronary artery disease, oedema, thromboembolism, dysmenorrhea, endometriosis, pre-eclampsia, lung disease, COPD, asthma bone disease, renal disease, glomerulonephritis, skin disease, liver disease, Crohn's disease, gastritis, ulcerative colitis, ulcer, immune disorder, autoimmune disease, arthritis, rheumatoid arthritis, psoriasis, epidermolysis bullosa, systemic lupus erythematosus,  
30 ankylosing spondylitis, Lyme disease, multiple sclerosis, neurodegeneration, stroke, brain/spinal cord injury, Alzheimer's disease, Parkinson's disease, motor neurone disease, neuromuscular disease, HIV, AIDS, cytomegalovirus infection, fungal infection, ocular

disorder, macular degeneration, glaucoma, diabetic retinopathy, ocular hypertension and other conditions in which immunoglobulin domain containing cell recognition molecules are implicated.

It is particularly preferred that the moieties of the first, second, third, fourth, fifth and sixth  
5 aspects of the invention are used in the manufacture of a medicament for the treatment of an inflammatory disease, an auto-immune disease, liver disease or liver failure.

In a thirteenth aspect, the invention provides a method of treating a disease in a patient comprising administering to the patient a polypeptide of the first aspect of the invention, or a nucleic acid molecule of the second or third aspect of the invention, or a vector of the  
10 fourth aspect of the invention, or a host cell of the fifth aspect of the invention, or a ligand of the sixth aspect of the invention, or a compound of the seventh aspect of the invention.

For diseases in which the expression of a natural gene encoding a polypeptide of the first aspect of the invention, or in which the activity of a polypeptide of the first aspect of the invention, is lower in a diseased patient when compared to the level of expression or  
15 activity in a healthy patient, the polypeptide, nucleic acid molecule, ligand or compound administered to the patient should be an agonist. Conversely, for diseases in which the expression of the natural gene or activity of the polypeptide is higher in a diseased patient when compared to the level of expression or activity in a healthy patient, the polypeptide, nucleic acid molecule, ligand or compound administered to the patient should be an  
20 antagonist. Examples of such antagonists include antisense nucleic acid molecules, ribozymes and ligands, such as antibodies.

Preferably, the disease is a disease in which immunoglobulin domain-containing cell surface recognition molecules are implicated, as described above.

It is particularly preferred that the disease is an inflammatory disease, an auto-immune  
25 disease, liver disease or liver failure.

In a fourteenth aspect, the invention provides transgenic or knockout non-human animals that have been transformed to express higher, lower or absent levels of a polypeptide of the first aspect of the invention. Such transgenic animals are very useful models for the study of disease and may also be used in screening regimes for the identification of compounds  
30 that are effective in the treatment or diagnosis of such a disease.

Preferably, the disease is a disease in which immunoglobulin domain-containing cell

surface recognition molecules are implicated, as described above.

It is particularly preferred that the disease is an inflammatory disease, an auto-immune disease, liver disease or liver failure.

It should be appreciated that the scope of protection sought for the polypeptides and  
5 nucleic acids of the present invention does not extend to nucleic acids or polypeptides present in their natural source. Rather, the polypeptides and nucleic acids claimed by the present invention may be regarded as being "isolated" or "purified". The terms "isolated" and "purified" as used herein refer to a nucleic acid or polypeptide separated from at least one other component (e. g., nucleic acid or polypeptide) present with the nucleic acid or  
10 polypeptide in its natural source. Thus, for example, a polypeptide contained in a tissue extract would constitute an "isolated" or "purified" polypeptide, as would a polypeptide synthetically or recombinantly produced. In one embodiment, the nucleic acid or polypeptide is found in the presence of (if anything) only a solvent, buffer, ion, or other component normally present in a solution of the same.

15 It should be noted that the terms "isolated" and "purified" do not denote the method by which the polypeptide or nucleic acid is obtained or the level of purity of the preparation. Thus, such isolated or purified species may be produced recombinantly, isolated directly from the cell or tissue of interest or produced synthetically based on the determined sequences.

A summary of standard techniques and procedures which may be employed in order to  
20 utilise the invention is given below. It will be understood that this invention is not limited to the particular methodology, protocols, cell lines, vectors and reagents described. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only and it is not intended that this terminology should limit the scope of the present invention. The extent of the invention is limited only by the terms of  
25 the appended claims.

Standard abbreviations for nucleotides and amino acids are used in this specification.

The practice of the present invention will employ, unless otherwise indicated, conventional techniques of molecular biology, microbiology, recombinant DNA technology and immunology, which are within the skill of those working in the art.

30 Such techniques are explained fully in the literature. Examples of particularly suitable texts

for consultation include the following: Sambrook Molecular Cloning; A Laboratory Manual, Second Edition (1989); DNA Cloning, Volumes I and II (D.N Glover ed. 1985); Oligonucleotide Synthesis (M.J. Gait ed. 1984); Nucleic Acid Hybridization (B.D. Hames & S.J. Higgins eds. 1984); Transcription and Translation (B.D. Hames & S.J. Higgins eds. 1984); Animal Cell Culture (R.I. Freshney ed. 1986); Immobilized Cells and Enzymes (IRL Press, 1986); B. Perbal, A Practical Guide to Molecular Cloning (1984); the Methods in Enzymology series (Academic Press, Inc.), especially volumes 154 & 155; Gene Transfer Vectors for Mammalian Cells (J.H. Miller and M.P. Calos eds. 1987, Cold Spring Harbor Laboratory); Immunochemical Methods in Cell and Molecular Biology (Mayer and Walker, eds. 1987, Academic Press, London); Scopes, (1987) Protein Purification: Principles and Practice, Second Edition (Springer Verlag, N.Y.); and Handbook of Experimental Immunology, Volumes I-IV (D.M. Weir and C. C. Blackwell eds. 1986).

As used herein, the term "polypeptide" includes any peptide or protein comprising two or more amino acids joined to each other by peptide bonds or modified peptide bonds, i.e. peptide isosteres. This term refers both to short chains (peptides and oligopeptides) and to longer chains (proteins).

The polypeptide of the present invention may be in the form of a mature protein or may be a pre-, pro- or prepro- protein that can be activated by cleavage of the pre-, pro- or prepro- portion to produce an active mature polypeptide. In such polypeptides, the pre-, pro- or prepro- sequence may be a leader or secretory sequence or may be a sequence that is employed for purification of the mature polypeptide sequence.

The polypeptide of the first aspect of the invention may form part of a fusion protein. For example, it is often advantageous to include one or more additional amino acid sequences which may contain secretory or leader sequences, pro-sequences, sequences which aid in purification, or sequences that confer higher protein stability, for example during recombinant production. Alternatively or additionally, the mature polypeptide may be fused with another compound, such as a compound to increase the half-life of the polypeptide (for example, polyethylene glycol).

Such fusion proteins can be obtained by cloning a polynucleotide encoding a polypeptide comprising a sequence having at least 85% homology with an INSP052 polypeptide in frame with the coding sequences for a heterologous protein sequence.

The term "heterologous", when used herein, is intended to designate any polypeptide other than a human INSP052 polypeptide. Examples of heterologous sequences, that can be comprised in the fusion proteins either at the N- or C-terminus, are described above and include: extracellular domains of membrane-bound protein, immunoglobulin constant  
5 regions (Fc regions), multimerization domains, domains of extracellular proteins, signal sequences, export sequences, and sequences allowing purification by affinity chromatography. If needed, the heterologous sequence can be eliminated by a proteolytic cleavage, as described above.

In a preferred embodiment, the protein is fused to the constant region of an Ig molecule.  
10 Preferably, it is fused to heavy chain regions, like the CH2 and CH3 domains of human IgG1, for example. Other isoforms of Ig molecules are also suitable for the generation of fusion proteins according to the present invention, such as isoforms IgG2 or IgG4, or other Ig classes, like IgM or IgA, for example. Fusion proteins may be monomeric or multimeric, hetero- or homomultimeric.

15 In a further preferred embodiment, the functional derivative comprises at least one moiety attached to one or more functional groups, which occur as one or more side chains on the amino acid residues. Preferably, the moiety is a polyethylene (PEG) moiety. PEGylation may be carried out by known methods, such as the ones described in WO99/55377, for example.

20 Polypeptides may contain amino acids other than the 20 gene-encoded amino acids, modified either by natural processes, such as by post-translational processing or by chemical modification techniques which are well known in the art. Among the known modifications which may commonly be present in polypeptides of the present invention are glycosylation, lipid attachment, sulphation, gamma-carboxylation, for instance of glutamic  
25 acid residues, hydroxylation and ADP-ribosylation. Other potential modifications include acetylation, acylation, amidation, covalent attachment of flavin, covalent attachment of a haeme moiety, covalent attachment of a nucleotide or nucleotide derivative, covalent attachment of a lipid derivative, covalent attachment of phosphatidylinositol, cross-linking, cyclization, disulphide bond formation, demethylation, formation of covalent cross-links,  
30 formation of cysteine, formation of pyroglutamate, formylation, GPI anchor formation, iodination, methylation, myristoylation, oxidation, proteolytic processing, phosphorylation, prenylation, racemization, selenoylation, transfer-RNA mediated addition of amino acids

to proteins such as arginylation, and ubiquitination.

In particular, the amino acid derivative may contain substituted or non-substituted alkyl moieties that can be linear, branched, or cyclic, and may include one or more heteroatoms. The amino acid derivatives can be made *de novo* or obtained from commercial sources  
5 (Calbiochem-Novabiochem AG, Switzerland; Bachem, USA).

These alterations are intended to provide the polypeptides of the invention with improved purification, potency and/or pharmacokinetics features. For example, when the peptide is susceptible to cleavage by peptidases following injection into the subject is a problem, replacement of a particularly sensitive peptide bond with a non-cleavable peptide mimetic  
10 can provide a peptide more stable and thus more useful as a therapeutic. Similarly, the replacement of an L-amino acid residue is a standard way of rendering the peptide less sensitive to proteolysis, and finally more similar to organic compounds other than peptides. Amino-terminal blocking groups such as t-butyloxycarbonyl, acetyl, theyl, succinyl, methoxysuccinyl, suberyl, adipyl, azelayl, dansyl, benzyloxycarbonyl,  
15 fluorenylmethoxycarbonyl, methoxyazelayl, methoxyadipyl, methoxysuberyl, and 2,4-dinitrophenyl may also be used to modify the polypeptides of the invention.

Many other modifications providing increased potency, prolonged activity, ease of purification, and/or increased half-life, and techniques for the synthesis and the development of peptide mimetics are known in the art (WO 02/10195; Villain M et al.,  
20 Chem Biol, 8: 673-679, 2001; Hruby VJ and Balse PM, Curr Med Chem, 7: 945-970, 2000; Golebiowski A et al., Curr Opin Drug Discov Devel, 4: 428-34, 2001). Various methodologies for incorporating unnatural amino acids into proteins, using both *in vitro* and *in vivo* translation systems, to probe and/or improve protein structure and function are also disclosed in the literature (Dougherty DA, Curr Opin Chem Biol, 4: 645-52, 2000).

25 Modifications can occur anywhere in a polypeptide, including the peptide backbone, the amino acid side-chains and the amino or carboxyl termini. In fact, blockage of the amino or carboxyl terminus in a polypeptide, or both, by a covalent modification is common in naturally-occurring and synthetic polypeptides and such modifications may be present in polypeptides of the present invention.

30 The modifications that occur in a polypeptide often will be a function of how the polypeptide is made. For polypeptides that are made recombinantly, the nature and extent

of the modifications in large part will be determined by the post-translational modification capacity of the particular host cell and the modification signals that are present in the amino acid sequence of the polypeptide in question. For instance, glycosylation patterns vary between different types of host cell.

- 5 The polypeptides of the present invention can be prepared in any suitable manner. Such polypeptides include isolated naturally-occurring polypeptides (for example purified from cell culture), recombinantly-produced polypeptides (including fusion proteins), synthetically-produced polypeptides or polypeptides that are produced by a combination of these methods.
- 10 The functionally-equivalent polypeptides of the first aspect of the invention may be polypeptides that are homologous to the INSP052 and INSP055 polypeptides, preferably the INSP052 extracellular domain (i.e. SEQ ID NO:20 or SEQ ID NO:22). Two polypeptides are said to be "homologous", as the term is used herein, if the sequence of one of the polypeptides has a high enough degree of identity or similarity to the sequence of the
- 15 other polypeptide. "Identity" indicates that at any particular position in the aligned sequences, the amino acid residue is identical between the sequences. "Similarity" indicates that, at any particular position in the aligned sequences, the amino acid residue is of a similar type between the sequences. Degrees of identity and similarity can be readily calculated (Computational Molecular Biology, Lesk, A.M., ed., Oxford University Press,
- 20 New York, 1988; Biocomputing. Informatics and Genome Projects, Smith, D.W., ed., Academic Press, New York, 1993; Computer Analysis of Sequence Data, Part 1, Griffin, A.M., and Griffin, H.G., eds., Humana Press, New Jersey, 1994; Sequence Analysis in Molecular Biology, von Heinje, G., Academic Press, 1987; and Sequence Analysis Primer, Gribskov, M. and Devereux, J., eds., M Stockton Press, New York, 1991).
- 25 Homologous polypeptides therefore include natural biological variants (for example, allelic variants or geographical variations within the species from which the polypeptides are derived) and mutants (such as mutants containing amino acid substitutions, insertions or deletions) of the INSP052 and INSP055 polypeptides, preferably of the INSP052 extracellular domain. Such mutants may include polypeptides in which one or more of the
- 30 amino acid residues are substituted with a conserved or non-conserved amino acid residue (preferably a conserved amino acid residue) and such substituted amino acid residue may or may not be one encoded by the genetic code. Typical such substitutions are among Ala,



Val, Leu and Ile; among Ser and Thr; among the acidic residues Asp and Glu; among Asn and Gln; among the basic residues Lys and Arg; or among the aromatic residues Phe and Tyr. Particularly preferred are variants in which several, i.e. between 5 and 10, 1 and 5, 1 and 3, 1 and 2 or just 1 amino acids are substituted, deleted or added in any combination.

- 5 Especially preferred are silent substitutions, additions and deletions, which do not alter the properties and activities of the protein. Also especially preferred in this regard are conservative substitutions. Such mutants also include polypeptides in which one or more of the amino acid residues includes a substituent group.

Typically, greater than 30% identity between two polypeptides is considered to be an indication of functional equivalence. Preferably, functionally equivalent polypeptides of the first aspect of the invention have a degree of sequence identity with the INSP052 and INSP055 polypeptides, or with active fragments thereof, of greater than 80%. More preferred polypeptides have degrees of identity of greater than 85%, 90%, 95%, 98% or 99%, respectively.

- 15 The functionally-equivalent polypeptides of the first aspect of the invention may also be polypeptides which have been identified using one or more techniques of structural alignment. For example, the Inpharmatica Genome Threader<sup>TM</sup> technology that forms one aspect of the search tools used to generate the Biopendium search database may be used (see co-pending International Patent Application No. PCT/GB01/01105, published as WO 01/69507) to identify polypeptides of presently-unknown function which, while having low sequence identity as compared to the INSP052 and INSP055 polypeptides, are predicted to be immunoglobulin domain-containing cell surface recognition molecules, said method utilising a polypeptide of the first aspect of the invention, by virtue of sharing significant structural homology with the INSP052 and INSP055 polypeptide sequences. By 25 "significant structural homology" is meant that the Inpharmatica Genome Threader<sup>TM</sup> predicts two proteins to share structural homology with a certainty of at least 10% and more preferably, at least 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and above.

The polypeptides of the first aspect of the invention also include fragments of the INSP052 and INSP055 polypeptides and fragments of the functional equivalents of the INSP052 and INSP055 polypeptides, provided that those fragments retain immunoglobulin domain-containing cell surface recognition molecule activity or have an antigenic determinant in common with the INSP052 and INSP055 polypeptides.

As used herein, the term "fragment" refers to a polypeptide having an amino acid sequence that is the same as part, but not all, of the amino acid sequence of the INSP052 and INSP055 polypeptides or one of its functional equivalents. The fragments should comprise at least n consecutive amino acids from the sequence and, depending on the particular  
5 sequence, n preferably is 7 or more (for example, 8, 10, 12, 14, 16, 18, 20 or more). Small fragments may form an antigenic determinant.

Such fragments may be "free-standing", i.e. not part of or fused to other amino acids or polypeptides, or they may be comprised within a larger polypeptide of which they form a part or region. When comprised within a larger polypeptide, the fragment of the invention  
10 most preferably forms a single continuous region. For instance, certain preferred embodiments relate to a fragment having a pre - and/or pro- polypeptide region fused to the amino terminus of the fragment and/or an additional region fused to the carboxyl terminus of the fragment. However, several fragments may be comprised within a single larger polypeptide.

15 The polypeptides of the present invention or their immunogenic fragments (comprising at least one antigenic determinant) can be used to generate ligands, such as polyclonal or monoclonal antibodies, that are immunospecific for the polypeptides. Such antibodies may be employed to isolate or to identify clones expressing the polypeptides of the invention or to purify the polypeptides by affinity chromatography. The antibodies may also be  
20 employed as diagnostic or therapeutic aids, amongst other applications, as will be apparent to the skilled reader.

The term "immunospecific" means that the antibodies have substantially greater affinity for the polypeptides of the invention than their affinity for other related polypeptides in the prior art. As used herein, the term "antibody" refers to intact molecules as well as to  
25 fragments thereof, such as Fab, F(ab')<sub>2</sub> and Fv, which are capable of binding to the antigenic determinant in question. Such antibodies thus bind to the polypeptides of the first aspect of the invention.

By "substantially greater affinity" we mean that there is a measurable increase in the affinity for a polypeptide of the invention as compared with the affinity for known  
30 immunoglobulin domain-containing cell surface recognition molecules.

Preferably, the affinity is at least 1.5-fold, 2-fold, 5-fold 10-fold, 100-fold, 10<sup>3</sup>-fold, 10<sup>4</sup>-

fold,  $10^5$ -fold or  $10^6$ -fold greater for a polypeptide of the invention than for known immunoglobulin domain-containing cell surface recognition molecules.

If polyclonal antibodies are desired, a selected mammal, such as a mouse, rabbit, goat or horse, may be immunised with a polypeptide of the first aspect of the invention. The polypeptide used to immunise the animal can be derived by recombinant DNA technology or can be synthesized chemically. If desired, the polypeptide can be conjugated to a carrier protein. Commonly used carriers to which the polypeptides may be chemically coupled include bovine serum albumin, thyroglobulin and keyhole limpet haemocyanin. The coupled polypeptide is then used to immunise the animal. Serum from the immunised animal is collected and treated according to known procedures, for example by immunoaffinity chromatography.

Monoclonal antibodies to the polypeptides of the first aspect of the invention can also be readily produced by one skilled in the art. The general methodology for making monoclonal antibodies using hybridoma technology is well known (see, for example, Kohler, G. and Milstein, C., *Nature* 256: 495-497 (1975); Kozbor *et al.*, *Immunology Today* 4: 72 (1983); Cole *et al.*, 77-96 in *Monoclonal Antibodies and Cancer Therapy*, Alan R. Liss, Inc. (1985).

Panels of monoclonal antibodies produced against the polypeptides of the first aspect of the invention can be screened for various properties, i.e., for isotype, epitope, affinity, etc. Monoclonal antibodies are particularly useful in purification of the individual polypeptides against which they are directed. Alternatively, genes encoding the monoclonal antibodies of interest may be isolated from hybridomas, for instance by PCR techniques known in the art, and cloned and expressed in appropriate vectors.

Chimeric antibodies, in which non-human variable regions are joined or fused to human constant regions (see, for example, Liu *et al.*, *Proc. Natl. Acad. Sci. USA*, 84, 3439 (1987)), may also be of use.

The antibody may be modified to make it less immunogenic in an individual, for example by humanisation (see Jones *et al.*, *Nature*, 321, 522 (1986); Verhoeyen *et al.*, *Science*, 239, 1534 (1988); Kabat *et al.*, *J. Immunol.*, 147, 1709 (1991); Queen *et al.*, *Proc. Natl. Acad. Sci. USA*, 86, 10029 (1989); Gorman *et al.*, *Proc. Natl. Acad. Sci. USA*, 88, 34181 (1991); and Hodgson *et al.*, *Bio/Technology*, 9, 421 (1991)). The term "humanised antibody", as

used herein, refers to antibody molecules in which the CDR amino acids and selected other amino acids in the variable domains of the heavy and/or light chains of a non-human donor antibody have been substituted in place of the equivalent amino acids in a human antibody. The humanised antibody thus closely resembles a human antibody but has the binding  
5 ability of the donor antibody.

In a further alternative, the antibody may be a "bispecific" antibody, that is an antibody having two different antigen binding domains, each domain being directed against a different epitope.

Phage display technology may be utilised to select genes which encode antibodies with  
10 binding activities towards the polypeptides of the invention either from repertoires of PCR amplified V-genes of lymphocytes from humans screened for possessing the relevant antibodies, or from naive libraries (McCafferty, J. *et al.*, (1990), Nature 348, 552-554; Marks, J. *et al.*, (1992) Biotechnology 10, 779-783). The affinity of these antibodies can also be improved by chain shuffling (Clackson, T. *et al.*, (1991) Nature 352, 624-628).

15 Antibodies generated by the above techniques, whether polyclonal or monoclonal, have additional utility in that they may be employed as reagents in immunoassays, radioimmunoassays (RIA) or enzyme-linked immunosorbent assays (ELISA). In these applications, the antibodies can be labelled with an analytically-detectable reagent such as a radioisotope, a fluorescent molecule or an enzyme.

20 Preferred nucleic acid molecules of the second and third aspects of the invention are those which encode the polypeptide sequences recited in SEQ ID NO:2, SEQ ID NO:4, SEQ ID NO:6, SEQ ID NO:8, SEQ ID NO:10, SEQ ID NO:12, SEQ ID NO:14 and/or SEQ ID NO:16, SEQ ID NO:18, the extracellular domain of INSP052 (SEQ ID NO:20 and SEQ ID NO:22), SEQ ID NO:24, or SEQ ID NO:26 and functionally equivalent polypeptides, e.g.  
25 variants of the INSP052 extracellular domain such as the Ig-domain containing fragment of INSP052 (SEQ ID NO:31), or fusion proteins consisting of the extracellular domain of INSP052 or variants thereof fused to one or more additional polypeptide sequences. These nucleic acid molecules may be used in the methods and applications described herein. The nucleic acid molecules of the invention preferably comprise at least n consecutive  
30 nucleotides from the sequences disclosed herein where, depending on the particular sequence, n is 10 or more (for example, 12, 14, 15, 18, 20, 25, 30, 35, 40 or more).

The nucleic acid molecules of the invention also include sequences that are complementary to nucleic acid molecules described above (for example, for antisense or probing purposes).

Nucleic acid molecules of the present invention may be in the form of RNA, such as mRNA, or in the form of DNA, including, for instance cDNA, synthetic DNA or genomic DNA. Such nucleic acid molecules may be obtained by cloning, by chemical synthetic techniques or by a combination thereof. The nucleic acid molecules can be prepared, for example, by chemical synthesis using techniques such as solid phase phosphoramidite chemical synthesis, from genomic or cDNA libraries or by separation from an organism.

10 RNA molecules may generally be generated by the *in vitro* or *in vivo* transcription of DNA sequences.

The nucleic acid molecules may be double-stranded or single-stranded. Single-stranded DNA may be the coding strand, also known as the sense strand, or it may be the non-coding strand, also referred to as the anti-sense strand.

15 The term "nucleic acid molecule" also includes analogues of DNA and RNA, such as those containing modified backbones, and peptide nucleic acids (PNA). The term "PNA", as used herein, refers to an antisense molecule or an anti-gene agent which comprises an oligonucleotide of at least five nucleotides in length linked to a peptide backbone of amino acid residues, which preferably ends in lysine. The terminal lysine confers solubility to the composition. PNAs may be pegylated to extend their lifespan in a cell, where they preferentially bind complementary single stranded DNA and RNA and stop transcript elongation (Nielsen, P.E. *et al.* (1993) *Anticancer Drug Des.* 8:53-63).

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These molecules also may have a different sequence which, as a result of the degeneracy of the genetic code, encode a polypeptide of SEQ ID NO:2, SEQ ID NO:4, SEQ ID NO:6, SEQ ID NO:8, SEQ ID NO:10, SEQ ID NO:12, SEQ ID NO:14 and/or SEQ ID NO:16, or SEQ ID NO:18, or the extracellular domain of INSP052 or variants thereof, SEQ ID NO:24 or SEQ ID NO:26 or SEQ ID NO:31. Such molecules may include, but are not limited to, the coding sequence for the mature polypeptide by itself; the coding sequence for the mature polypeptide and additional coding sequences, such as those encoding a leader or secretory sequence, such as a pro-, pre- or prepro- polypeptide sequence; the coding sequence of the mature polypeptide, with or without the aforementioned additional coding sequences, together with further additional, non-coding sequences, including non-

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coding 5' and 3' sequences, such as the transcribed, non-translated sequences that play a role in transcription (including termination signals), ribosome binding and mRNA stability. The nucleic acid molecules may also include additional sequences which encode additional amino acids, such as those which provide additional functionalities.

- 5 The nucleic acid molecules of the second and third aspects of the invention may also encode the fragments or the functional equivalents of the polypeptides and fragments of the first aspect of the invention. Such a nucleic acid molecule may be a naturally-occurring variant such as a naturally-occurring allelic variant, or the molecule may be a variant that is not known to occur naturally. Such non-naturally occurring variants of the nucleic acid  
10 molecule may be made by mutagenesis techniques, including those applied to nucleic acid molecules, cells or organisms.

- Among variants in this regard are variants that differ from the aforementioned nucleic acid molecules by nucleotide substitutions, deletions or insertions. The substitutions, deletions or insertions may involve one or more nucleotides. The variants may be altered in coding  
15 or non-coding regions or both. Alterations in the coding regions may produce conservative or non-conservative amino acid substitutions, deletions or insertions.

- The nucleic acid molecules of the invention can also be engineered, using methods generally known in the art, for a variety of reasons, including modifying the cloning, processing, and/or expression of the gene product (the polypeptide). DNA shuffling by  
20 random fragmentation and PCR reassembly of gene fragments and synthetic oligonucleotides are included as techniques which may be used to engineer the nucleotide sequences. Site-directed mutagenesis may be used to insert new restriction sites, alter glycosylation patterns, change codon preference, produce splice variants, introduce mutations and so forth.

- 25 Nucleic acid molecules which encode a polypeptide of the first aspect of the invention may be ligated to a heterologous sequence so that the combined nucleic acid molecule encodes a fusion protein. Such combined nucleic acid molecules are included within the second or third aspects of the invention. For example, to screen peptide libraries for inhibitors of the activity of the polypeptide, it may be useful to express, using such a combined nucleic acid  
30 molecule, a fusion protein that can be recognised by a commercially-available antibody. A fusion protein may also be engineered to contain a cleavage site located between the sequence of the polypeptide of the invention and the sequence of a heterologous protein so

that the polypeptide may be cleaved and purified away from the heterologous protein.

The nucleic acid molecules of the invention also include antisense molecules that are partially complementary to nucleic acid molecules encoding polypeptides of the present invention and that therefore hybridize to the encoding nucleic acid molecules  
5 (hybridization). Such antisense molecules, such as oligonucleotides, can be designed to recognise, specifically bind to and prevent transcription of a target nucleic acid encoding a polypeptide of the invention, as will be known by those of ordinary skill in the art (see, for example, Cohen, J.S., Trends in Pharm. Sci., 10, 435 (1989), Okano, J. Neurochem. 56, 560 (1991); O'Connor, J. Neurochem 56, 560 (1991); Lee *et al.*, Nucleic Acids Res 6, 3073  
10 (1979); Cooney *et al.*, Science 241, 456 (1988); Dervan *et al.*, Science 251, 1360 (1991).

The term "hybridization" as used herein refers to the association of two nucleic acid molecules with one another by hydrogen bonding. Typically, one molecule will be fixed to a solid support and the other will be free in solution. Then, the two molecules may be placed in contact with one another under conditions that favour hydrogen bonding. Factors  
15 that affect this bonding include: the type and volume of solvent; reaction temperature; time of hybridization; agitation; agents to block the non-specific attachment of the liquid phase molecule to the solid support (Denhardt's reagent or BLOTTO); the concentration of the molecules; use of compounds to increase the rate of association of molecules (dextran sulphate or polyethylene glycol); and the stringency of the washing conditions following  
20 hybridization (see Sambrook *et al.* [*supra*]).

The inhibition of hybridization of a completely complementary molecule to a target molecule may be examined using a hybridization assay, as known in the art (see, for example, Sambrook *et al* [*supra*]). A substantially homologous molecule will then compete for and inhibit the binding of a completely homologous molecule to the target molecule  
25 under various conditions of stringency, as taught in Wahl, G.M. and S.L. Berger (1987; Methods Enzymol. 152:399-407) and Kimmel, A.R. (1987; Methods Enzymol. 152:507-511).

"Stringency" refers to conditions in a hybridization reaction that favour the association of very similar molecules over association of molecules that differ. High stringency  
30 hybridisation conditions are defined as overnight incubation at 42°C in a solution comprising 50% formamide, 5XSSC (150mM NaCl, 15mM trisodium citrate), 50mM sodium phosphate (pH7.6), 5x Denhardts solution, 10% dextran sulphate, and 20

microgram/ml denatured, sheared salmon sperm DNA, followed by washing the filters in 0.1X SSC at approximately 65°C. Low stringency conditions involve the hybridisation reaction being carried out at 35°C (see Sambrook *et al.* [*supra*]). Preferably, the conditions used for hybridization are those of high stringency.

- 5 Preferred embodiments of this aspect of the invention are nucleic acid molecules that are at least 70% identical over their entire length to a nucleic acid molecule encoding the INSP052 or INSP055 polypeptides (SEQ ID NO:1, SEQ ID NO:3, SEQ ID NO:5, SEQ ID NO:7, SEQ ID NO:9, SEQ ID NO:11, SEQ ID NO:13 and/or SEQ ID NO:15, or SEQ ID NO:17, or the nucleic acid sequence set forth in Figure 7 or the coding portion of the
- 10 nucleic acid sequence set forth in Figure 7 (i.e. SEQ ID NO: 19 or SEQ ID NO: 21), SEQ ID NO: 23, or SEQ ID NO: 25) and nucleic acid molecules that are substantially complementary to such nucleic acid molecules. Preferably, a nucleic acid molecule according to this aspect of the invention comprises a region that is at least 80% identical over its entire length to the coding sequence for SEQ ID NO:2 given in SEQ ID NO:1, the
- 15 coding sequence for SEQ ID NO:4 given in SEQ ID NO:3, the coding sequences for SEQ ID NO:6 given in SEQ ID NO:5, the coding sequence for SEQ ID NO:8 given in SEQ ID NO:7, the coding sequence for SEQ ID NO:10 given in SEQ ID NO:9, the coding sequence for SEQ ID NO:12 given in SEQ ID NO:11, the coding sequence for SEQ ID NO:14 given in SEQ ID NO:13, the coding sequence for SEQ ID NO:16 given in SEQ ID
- 20 NO:15, the coding sequence for SEQ ID NO:18 given in SEQ ID NO:17, the coding sequence for SEQ ID NO:24 given in SEQ ID NO:23, the coding sequence for SEQ ID NO: 26 given in SEQ ID NO: 25, or is a nucleic acid molecule that is complementary thereto. Particularly preferred is a nucleic acid which comprises or consists of a region that is at least 80% identical over its entire length to the coding sequence for the extracellular
- 25 domain of INSP052 (the extracellular domain of mature INSP052 or the extracellular domain of INSP052 comprising the signal peptide) as given in Figure 7. In this regard, nucleic acid molecules at least 90%, preferably at least 95%, more preferably at least 98% or 99% identical over their entire length to the same are particularly preferred. Preferred embodiments in this respect are nucleic acid molecules that encode polypeptides which
- 30 retain substantially the same biological function or activity as the INSP052 and INSP055 polypeptides.

The invention also provides a process for detecting a nucleic acid molecule of the



invention, comprising the steps of: (a) contacting a nucleic probe according to the invention with a biological sample under hybridizing conditions to form duplexes; and (b) detecting any such duplexes that are formed.

- As discussed additionally below in connection with assays that may be utilised according to the invention, a nucleic acid molecule as described above may be used as a hybridization probe for RNA, cDNA or genomic DNA, in order to isolate full-length cDNAs and genomic clones encoding the INSP052 and INSP055 polypeptides and to isolate cDNA and genomic clones of homologous or orthologous genes that have a high sequence similarity to the gene encoding this polypeptide.
- 10 In this regard, the following techniques, among others known in the art, may be utilised and are discussed below for purposes of illustration. Methods for DNA sequencing and analysis are well known and are generally available in the art and may, indeed, be used to practice many of the embodiments of the invention discussed herein. Such methods may employ such enzymes as the Klenow fragment of DNA polymerase I, Sequenase (US
- 15 Biochemical Corp, Cleveland, OH), Taq polymerase (Perkin Elmer), thermostable T7 polymerase (Amersham, Chicago, IL), or combinations of polymerases and proof-reading exonucleases such as those found in the ELONGASE Amplification System marketed by Gibco/BRL (Gaithersburg, MD). Preferably, the sequencing process may be automated using machines such as the Hamilton Micro Lab 2200 (Hamilton, Reno, NV), the Peltier
- 20 Thermal Cycler (PTC200; MJ Research, Watertown, MA) and the ABI Catalyst and 373 and 377 DNA Sequencers (Perkin Elmer).

- One method for isolating a nucleic acid molecule encoding a polypeptide with an equivalent function to that of the INSP052 and INSP055 polypeptides is to probe a genomic or cDNA library with a natural or artificially-designed probe using standard
- 25 procedures that are recognised in the art (see, for example, "Current Protocols in Molecular Biology", Ausubel *et al.* (eds). Greene Publishing Association and John Wiley Interscience, New York, 1989,1992). Probes comprising at least 15, preferably at least 30, and more preferably at least 50, contiguous bases that correspond to, or are complementary to, nucleic acid sequences from the appropriate encoding gene (SEQ ID NO:1, SEQ ID
- 30 NO:3, SEQ ID NO:5, SEQ ID NO:7, SEQ ID NO:9, SEQ ID NO:11, SEQ ID NO:13, SEQ ID NO:15, SEQ ID NO:17, SEQ ID NO: 19, SEQ ID NO: 21, SEQ ID NO: 23, SEQ ID NO: 25) are particularly useful probes. Such probes may be labelled with an analytically-

detectable reagent to facilitate their identification. Useful reagents include, but are not limited to, radioisotopes, fluorescent dyes and enzymes that are capable of catalysing the formation of a detectable product. Using these probes, the ordinarily skilled artisan will be capable of isolating complementary copies of genomic DNA, cDNA or RNA  
5 polynucleotides encoding proteins of interest from human, mammalian or other animal sources and screening such sources for related sequences, for example, for additional members of the family, type and/or subtype.

In many cases, isolated cDNA sequences will be incomplete, in that the region encoding the polypeptide will be cut short, normally at the 5' end. Several methods are available to  
10 obtain full length cDNAs, or to extend short cDNAs. Such sequences may be extended utilising a partial nucleotide sequence and employing various methods known in the art to detect upstream sequences such as promoters and regulatory elements. For example, one method which may be employed is based on the method of Rapid Amplification of cDNA Ends (RACE; see, for example, Frohman *et al.*, PNAS USA 85, 8998-9002, 1988). Recent  
15 modifications of this technique, exemplified by the Marathon<sup>TM</sup> technology (Clontech Laboratories Inc.), for example, have significantly simplified the search for longer cDNAs. A slightly different technique, termed "restriction-site" PCR, uses universal primers to retrieve unknown nucleic acid sequence adjacent a known locus (Sarkar, G. (1993) PCR Methods Applic. 2:318-322). Inverse PCR may also be used to amplify or to extend  
20 sequences using divergent primers based on a known region (Triglia, T. *et al.* (1988) Nucleic Acids Res. 16:8186). Another method which may be used is capture PCR which involves PCR amplification of DNA fragments adjacent a known sequence in human and yeast artificial chromosome DNA (Lagerstrom, M. *et al.* (1991) PCR Methods Applic., 1, 111-119). Another method which may be used to retrieve unknown sequences is that of  
25 Parker, J.D. *et al.* (1991); Nucleic Acids Res. 19:3055-3060). Additionally, one may use PCR, nested primers, and PromoterFinder<sup>TM</sup> libraries to walk genomic DNA (Clontech, Palo Alto, CA). This process avoids the need to screen libraries and is useful in finding intron/exon junctions.

When screening for full-length cDNAs, it is preferable to use libraries that have been size-  
30 selected to include larger cDNAs. Also, random-primed libraries are preferable, in that they will contain more sequences that contain the 5' regions of genes. Use of a randomly primed library may be especially preferable for situations in which an oligo d(T) library

does not yield a full-length cDNA. Genomic libraries may be useful for extension of sequence into 5' non-transcribed regulatory regions.

In one embodiment of the invention, the nucleic acid molecules of the present invention may be used for chromosome localisation. In this technique, a nucleic acid molecule is specifically targeted to, and can hybridize with, a particular location on an individual human chromosome. The mapping of relevant sequences to chromosomes according to the present invention is an important step in the confirmatory correlation of those sequences with the gene-associated disease. Once a sequence has been mapped to a precise chromosomal location, the physical position of the sequence on the chromosome can be correlated with genetic map data. Such data are found in, for example, V. McKusick, Mendelian Inheritance in Man (available on-line through Johns Hopkins University Welch Medical Library). The relationships between genes and diseases that have been mapped to the same chromosomal region are then identified through linkage analysis (coinheritance of physically adjacent genes). This provides valuable information to investigators searching for disease genes using positional cloning or other gene discovery techniques. Once the disease or syndrome has been crudely localised by genetic linkage to a particular genomic region, any sequences mapping to that area may represent associated or regulatory genes for further investigation. The nucleic acid molecule may also be used to detect differences in the chromosomal location due to translocation, inversion, etc. among normal, carrier, or affected individuals.

The nucleic acid molecules of the present invention are also valuable for tissue localisation. Such techniques allow the determination of expression patterns of the polypeptide in tissues by detection of the mRNAs that encode them. These techniques include *in situ* hybridization techniques and nucleotide amplification techniques, such as PCR. Results from these studies provide an indication of the normal functions of the polypeptide in the organism. In addition, comparative studies of the normal expression pattern of mRNAs with that of mRNAs encoded by a mutant gene provide valuable insights into the role of mutant polypeptides in disease. Such inappropriate expression may be of a temporal, spatial or quantitative nature.

Gene silencing approaches may also be undertaken to down-regulate endogenous expression of a gene encoding a polypeptide of the invention. RNA interference (RNAi) (Elbashir, SM *et al.*, Nature 2001, 411, 494-498) is one method of sequence specific post-

transcriptional gene silencing that may be employed. Short dsRNA oligonucleotides are synthesised *in vitro* and introduced into a cell. The sequence specific binding of these dsRNA oligonucleotides triggers the degradation of target mRNA, reducing or ablating target protein expression.

- 5 Efficacy of the gene silencing approaches assessed above may be assessed through the measurement of polypeptide expression (for example, by Western blotting), and at the RNA level using TaqMan-based methodologies.

The vectors of the present invention comprise nucleic acid molecules of the invention and may be cloning or expression vectors. The host cells of the invention, which may be  
10 transformed, transfected or transduced with the vectors of the invention may be prokaryotic or eukaryotic.

The polypeptides of the invention may be prepared in recombinant form by expression of their encoding nucleic acid molecules in vectors contained within a host cell. Such expression methods are well known to those of skill in the art and many are described in  
15 detail by Sambrook *et al* (*supra*) and Fernandez & Hoeffler (1998, eds. "Gene expression systems. Using nature for the art of expression". Academic Press, San Diego, London, Boston, New York, Sydney, Tokyo, Toronto).

Generally, any system or vector that is suitable to maintain, propagate or express nucleic acid molecules to produce a polypeptide in the required host may be used. The appropriate  
20 nucleotide sequence may be inserted into an expression system by any of a variety of well-known and routine techniques, such as, for example, those described in Sambrook *et al.*, (*supra*). Generally, the encoding gene can be placed under the control of a control element such as a promoter, ribosome binding site (for bacterial expression) and, optionally, an operator, so that the DNA sequence encoding the desired polypeptide is transcribed into  
25 RNA in the transformed host cell.

Examples of suitable expression systems include, for example, chromosomal, episomal and virus-derived systems, including, for example, vectors derived from: bacterial plasmids, bacteriophage, transposons, yeast episomes, insertion elements, yeast chromosomal elements, viruses such as baculoviruses, papova viruses such as SV40, vaccinia viruses,  
30 adenoviruses, fowl pox viruses, pseudorabies viruses and retroviruses, or combinations thereof, such as those derived from plasmid and bacteriophage genetic elements, including

cosmids and phagemids. Human artificial chromosomes (HACs) may also be employed to deliver larger fragments of DNA than can be contained and expressed in a plasmid.

Particularly suitable expression systems include microorganisms such as bacteria transformed with recombinant bacteriophage, plasmid or cosmid DNA expression vectors; 5 yeast transformed with yeast expression vectors; insect cell systems infected with virus expression vectors (for example, baculovirus); plant cell systems transformed with virus expression vectors (for example, cauliflower mosaic virus, CaMV; tobacco mosaic virus, TMV) or with bacterial expression vectors (for example, Ti or pBR322 plasmids); or animal cell systems. Cell-free translation systems can also be employed to produce the 10 polypeptides of the invention.

Introduction of nucleic acid molecules encoding a polypeptide of the present invention into host cells can be effected by methods described in many standard laboratory manuals, such as Davis *et al.*, Basic Methods in Molecular Biology (1986) and Sambrook *et al.*, [supra]. Particularly suitable methods include calcium phosphate transfection, DEAE-dextran 15 mediated transfection, transvection, microinjection, cationic lipid-mediated transfection, electroporation, transduction, scrape loading, ballistic introduction or infection (see Sambrook *et al.*, 1989 [supra]; Ausubel *et al.*, 1991 [supra]; Spector, Goldman & Leinwald, 1998). In eukaryotic cells, expression systems may either be transient (for example, episomal) or permanent (chromosomal integration) according to the needs of the 20 system.

The encoding nucleic acid molecule may or may not include a sequence encoding a control sequence, such as a signal peptide or leader sequence, as desired, for example, for secretion of the translated polypeptide into the lumen of the endoplasmic reticulum, into the periplasmic space or into the extracellular environment. These signals may be endogenous 25 to the polypeptide or they may be heterologous signals. Leader sequences can be removed by the bacterial host in post-translational processing.

In addition to control sequences, it may be desirable to add regulatory sequences that allow for regulation of the expression of the polypeptide relative to the growth of the host cell. Examples of regulatory sequences are those which cause the expression of a gene to be 30 increased or decreased in response to a chemical or physical stimulus, including the presence of a regulatory compound or to various temperature or metabolic conditions. Regulatory sequences are those non-translated regions of the vector, such as enhancers,

promoters and 5' and 3' untranslated regions. These interact with host cellular proteins to carry out transcription and translation. Such regulatory sequences may vary in their strength and specificity. Depending on the vector system and host utilised, any number of suitable transcription and translation elements, including constitutive and inducible promoters, may be used. For example, when cloning in bacterial systems, inducible promoters such as the hybrid lacZ promoter of the Bluescript phagemid (Stratagene, LaJolla, CA) or pSportl<sup>TM</sup> plasmid (Gibco BRL) and the like may be used. The baculovirus polyhedrin promoter may be used in insect cells. Promoters or enhancers derived from the genomes of plant cells (for example, heat shock, RUBISCO and storage protein genes) or from plant viruses (for example, viral promoters or leader sequences) may be cloned into the vector. In mammalian cell systems, promoters from mammalian genes or from mammalian viruses are preferable. If it is necessary to generate a cell line that contains multiple copies of the sequence, vectors based on SV40 or EBV may be used with an appropriate selectable marker.

An expression vector is constructed so that the particular nucleic acid coding sequence is located in the vector with the appropriate regulatory sequences, the positioning and orientation of the coding sequence with respect to the regulatory sequences being such that the coding sequence is transcribed under the "control" of the regulatory sequences, i.e., RNA polymerase which binds to the DNA molecule at the control sequences transcribes the coding sequence. In some cases it may be necessary to modify the sequence so that it may be attached to the control sequences with the appropriate orientation; i.e., to maintain the reading frame.

The control sequences and other regulatory sequences may be ligated to the nucleic acid coding sequence prior to insertion into a vector. Alternatively, the coding sequence can be cloned directly into an expression vector that already contains the control sequences and an appropriate restriction site.

For long-term, high-yield production of a recombinant polypeptide, stable expression is preferred. For example, cell lines which stably express the polypeptide of interest may be transformed using expression vectors which may contain viral origins of replication and/or endogenous expression elements and a selectable marker gene on the same or on a separate vector. Following the introduction of the vector, cells may be allowed to grow for 1-2 days in an enriched media before they are switched to selective media. The purpose of the

selectable marker is to confer resistance to selection, and its presence allows growth and recovery of cells that successfully express the introduced sequences. Resistant clones of stably transformed cells may be proliferated using tissue culture techniques appropriate to the cell type.

- 5 Mammalian cell lines available as hosts for expression are known in the art and include many immortalised cell lines available from the American Type Culture Collection (ATCC) including, but not limited to, Chinese hamster ovary (CHO), HeLa, baby hamster kidney (BHK), monkey kidney (COS), C127, 3T3, BHK, HEK 293, Bowes melanoma and human hepatocellular carcinoma (for example Hep G2) cells and a number of other cell  
10 lines.

- In the baculovirus system, the materials for baculovirus/insect cell expression systems are commercially available in kit form from, inter alia, Invitrogen, San Diego CA (the "MaxBac" kit). These techniques are generally known to those skilled in the art and are described fully in Summers and Smith, Texas Agricultural Experiment Station Bulletin No.  
15 1555 (1987). Particularly suitable host cells for use in this system include insect cells such as *Drosophila* S2 and *Spodoptera* Sf9 cells.

- There are many plant cell culture and whole plant genetic expression systems known in the art. Examples of suitable plant cellular genetic expression systems include those described in US 5,693,506; US 5,659,122; and US 5,608,143. Additional examples of genetic  
20 expression in plant cell culture has been described by Zenk, *Phytochemistry* 30, 3861-3863 (1991).

- In particular, all plants from which protoplasts can be isolated and cultured to give whole regenerated plants can be utilised, so that whole plants are recovered which contain the transferred gene. Practically all plants can be regenerated from cultured cells or tissues,  
25 including but not limited to all major species of sugar cane, sugar beet, cotton, fruit and other trees, legumes and vegetables.

Examples of particularly preferred bacterial host cells include streptococci, staphylococci, *E. coli*, *Streptomyces* and *Bacillus subtilis* cells.

- Examples of particularly suitable host cells for fungal expression include yeast cells (for  
30 example, *S. cerevisiae*) and *Aspergillus* cells.

Any number of selection systems are known in the art that may be used to recover

transformed cell lines. Examples include the herpes simplex virus thymidine kinase (Wigler, M. *et al.* (1977) Cell 11:223-32) and adenine phosphoribosyltransferase (Lowy, I. *et al.* (1980) Cell 22:817-23) genes that can be employed in tk- or apt<sup>±</sup> cells, respectively.

Also, antimetabolite, antibiotic or herbicide resistance can be used as the basis for selection; for example, dihydrofolate reductase (DHFR) that confers resistance to methotrexate (Wigler, M. *et al.* (1980) Proc. Natl. Acad. Sci. 77:3567-70); npt, which confers resistance to the aminoglycosides neomycin and G-418 (Colbere-Garapin, F. *et al.* (1981) J. Mol. Biol. 150:1-14) and als or pat, which confer resistance to chlorsulfuron and phosphinotricin acetyltransferase, respectively. Additional selectable genes have been described, examples of which will be clear to those of skill in the art.

Although the presence or absence of marker gene expression suggests that the gene of interest is also present, its presence and expression may need to be confirmed. For example, if the relevant sequence is inserted within a marker gene sequence, transformed cells containing the appropriate sequences can be identified by the absence of marker gene function. Alternatively, a marker gene can be placed in tandem with a sequence encoding a polypeptide of the invention under the control of a single promoter. Expression of the marker gene in response to induction or selection usually indicates expression of the tandem gene as well.

Alternatively, host cells that contain a nucleic acid sequence encoding a polypeptide of the invention and which express said polypeptide may be identified by a variety of procedures known to those of skill in the art. These procedures include, but are not limited to, DNA-DNA or DNA-RNA hybridizations and protein bioassays, for example, fluorescence activated cell sorting (FACS) or immunoassay techniques (such as the enzyme-linked immunosorbent assay [ELISA] and radioimmunoassay [RIA]), that include membrane, solution, or chip based technologies for the detection and/or quantification of nucleic acid or protein (see Hampton, R. *et al.* (1990) Serological Methods, a Laboratory Manual, APS Press, St Paul, MN) and Maddox, D.E. *et al.* (1983) J. Exp. Med, 158, 1211-1216).

A wide variety of labels and conjugation techniques are known by those skilled in the art and may be used in various nucleic acid and amino acid assays. Means for producing labelled hybridization or PCR probes for detecting sequences related to nucleic acid molecules encoding polypeptides of the present invention include oligolabelling, nick translation, end-labelling or PCR amplification using a labelled polynucleotide.



Alternatively, the sequences encoding the polypeptide of the invention may be cloned into a vector for the production of an mRNA probe. Such vectors are known in the art, are commercially available, and may be used to synthesise RNA probes *in vitro* by addition of an appropriate RNA polymerase such as T7, T3 or SP6 and labelled nucleotides. These  
5 procedures may be conducted using a variety of commercially available kits (Pharmacia & Upjohn, (Kalamazoo, MI); Promega (Madison WI); and U.S. Biochemical Corp., Cleveland, OH)).

Suitable reporter molecules or labels, which may be used for ease of detection, include radionuclides, enzymes and fluorescent, chemiluminescent or chromogenic agents as well  
10 as substrates, cofactors, inhibitors, magnetic particles, and the like.

Nucleic acid molecules according to the present invention may also be used to create transgenic animals, particularly rodent animals. Such transgenic animals form a further aspect of the present invention. This may be done locally by modification of somatic cells, or by germ line therapy to incorporate heritable modifications. Such transgenic animals  
15 may be particularly useful in the generation of animal models for drug molecules effective as modulators of the polypeptides of the present invention.

The polypeptide can be recovered and purified from recombinant cell cultures by well-known methods including ammonium sulphate or ethanol precipitation, acid extraction, anion or cation exchange chromatography, phosphocellulose chromatography,  
20 hydrophobic interaction chromatography, affinity chromatography, hydroxylapatite chromatography and lectin chromatography. High performance liquid chromatography is particularly useful for purification. Well known techniques for refolding proteins may be employed to regenerate an active conformation when the polypeptide is denatured during isolation and or purification.

Specialised vector constructions may also be used to facilitate purification of proteins, as desired, by joining sequences encoding the polypeptides of the invention to a nucleotide sequence encoding a polypeptide domain that will facilitate purification of soluble proteins. Examples of such purification-facilitating domains include metal chelating peptides such as histidine-tryptophan modules that allow purification on immobilised  
25 metals, protein A domains that allow purification on immobilised immunoglobulin, and the domain utilised in the FLAGS extension/affinity purification system (Immunex Corp., Seattle, WA). The inclusion of cleavable linker sequences such as those specific for Factor  
30

- XA or enterokinase (Invitrogen, San Diego, CA) between the purification domain and the polypeptide of the invention may be used to facilitate purification. One such expression vector provides for expression of a fusion protein containing the polypeptide of the invention fused to several histidine residues preceding a thioredoxin or an enterokinase cleavage site. The histidine residues facilitate purification by IMAC (immobilised metal ion affinity chromatography as described in Porath, J. *et al.* (1992), Prot. Exp. Purif. 3: 263-281) while the thioredoxin or enterokinase cleavage site provides a means for purifying the polypeptide from the fusion protein. A discussion of vectors which contain fusion proteins is provided in Kroll, D.J. *et al.* (1993; DNA Cell Biol. 12:441-453).
- 10 If the polypeptide is to be expressed for use in screening assays, generally it is preferred that it be produced at the surface of the host cell in which it is expressed. In this event, the host cells may be harvested prior to use in the screening assay, for example using techniques such as fluorescence activated cell sorting (FACS) or immunoaffinity techniques. If the polypeptide is secreted into the medium, the medium can be recovered in order to recover and purify the expressed polypeptide. If polypeptide is produced intracellularly, the cells must first be lysed before the polypeptide is recovered.

- The polypeptide of the invention can be used to screen libraries of compounds in any of a variety of drug screening techniques. Such compounds may activate (agonise) or inhibit (antagonise) the level of expression of the gene or the activity of the polypeptide of the invention and form a further aspect of the present invention. Preferred compounds are effective to alter the expression of a natural gene which encodes a polypeptide of the first aspect of the invention or to regulate the activity of a polypeptide of the first aspect of the invention.

- Agonist or antagonist compounds may be isolated from, for example, cells, cell-free preparations, chemical libraries or natural product mixtures. These agonists or antagonists may be natural or modified substrates, ligands, enzymes, receptors or structural or functional mimetics. For a suitable review of such screening techniques, see Coligan *et al.*, Current Protocols in Immunology 1(2):Chapter 5 (1991).

- Compounds that are most likely to be good antagonists are molecules that bind to the polypeptide of the invention without inducing the biological effects of the polypeptide upon binding to it. Potential antagonists include small organic molecules, peptides, polypeptides and antibodies that bind to the polypeptide of the invention and thereby

inhibit or extinguish its activity. In this fashion, binding of the polypeptide to normal cellular binding molecules may be inhibited, such that the normal biological activity of the polypeptide is prevented.

The polypeptide of the invention that is employed in such a screening technique may be free in solution, affixed to a solid support, borne on a cell surface or located intracellularly. In general, such screening procedures may involve using appropriate cells or cell membranes that express the polypeptide that are contacted with a test compound to observe binding, or stimulation or inhibition of a functional response. The functional response of the cells contacted with the test compound is then compared with control cells that were not contacted with the test compound. Such an assay may assess whether the test compound results in a signal generated by activation of the polypeptide, using an appropriate detection system. Inhibitors of activation are generally assayed in the presence of a known agonist and the effect on activation by the agonist in the presence of the test compound is observed.

A preferred method for identifying an agonist or antagonist compound of a polypeptide of the present invention comprises:

(a) contacting a cell expressing on the surface thereof the polypeptide according to the first aspect of the invention, the polypeptide being associated with a second component capable of providing a detectable signal in response to the binding of a compound to the polypeptide, with a compound to be screened under conditions to permit binding to the polypeptide; and

(b) determining whether the compound binds to and activates or inhibits the polypeptide by measuring the level of a signal generated from the interaction of the compound with the polypeptide.

A further preferred method for identifying an agonist or antagonist of a polypeptide of the invention comprises:

(a) contacting a cell expressing on the surface thereof the polypeptide, the polypeptide being associated with a second component capable of providing a detectable signal in response to the binding of a compound to the polypeptide, with a compound to be screened under conditions to permit binding to the polypeptide; and

(b) determining whether the compound binds to and activates or inhibits the polypeptide by

comparing the level of a signal generated from the interaction of the compound with the polypeptide with the level of a signal in the absence of the compound.

In further preferred embodiments, the general methods that are described above may further comprise conducting the identification of agonist or antagonist in the presence of  
5 labelled or unlabelled ligand for the polypeptide. The skilled person will understand that the term “ligand” encompasses any moiety that binds specifically to the polypeptide of the first aspect of the invention including, for example, antibodies and orphan receptors.

In another embodiment of the method for identifying agonist or antagonist of a polypeptide of the present invention comprises:

- 10 determining the inhibition of binding of a ligand to cells which have a polypeptide of the invention on the surface thereof, or to cell membranes containing such a polypeptide, in the presence of a candidate compound under conditions to permit binding to the polypeptide, and determining the amount of ligand bound to the polypeptide. A compound capable of causing reduction of binding of a ligand is considered to be an agonist or antagonist.
- 15 Preferably the ligand is labelled.

More particularly, a method of screening for a polypeptide antagonist or agonist compound comprises the steps of:

- (a) incubating a labelled ligand with a whole cell expressing a polypeptide according to the invention on the cell surface, or a cell membrane containing a polypeptide of the invention,
- 20 (b) measuring the amount of labelled ligand bound to the whole cell or the cell membrane;
- (c) adding a candidate compound to a mixture of labelled ligand and the whole cell or the cell membrane of step (a) and allowing the mixture to attain equilibrium;
- (d) measuring the amount of labelled ligand bound to the whole cell or the cell membrane after step (c); and
- 25 (e) comparing the difference in the labelled ligand bound in step (b) and (d), such that the compound which causes the reduction in binding in step (d) is considered to be an agonist or antagonist.

The polypeptides may be found to modulate a variety of physiological and pathological processes in a dose-dependent manner in the above-described assays. Thus, the “functional  
30 equivalents” of the polypeptides of the invention include polypeptides that exhibit any of

the same modulatory activities in the above-described assays in a dose-dependent manner. Although the degree of dose-dependent activity need not be identical to that of the polypeptides of the invention, preferably the "functional equivalents" will exhibit substantially similar dose-dependence in a given activity assay compared to the  
5 polypeptides of the invention.

In certain of the embodiments described above, simple binding assays may be used, in which the adherence of a test compound to a surface bearing the polypeptide is detected by means of a label directly or indirectly associated with the test compound or in an assay involving competition with a labelled competitor. In another embodiment, competitive  
10 drug screening assays may be used, in which neutralising antibodies that are capable of binding the polypeptide specifically compete with a test compound for binding. In this manner, the antibodies can be used to detect the presence of any test compound that possesses specific binding affinity for the polypeptide.

Persons skilled in the art will be able to devise assays for identifying modulators of a  
15 polypeptide of the invention. Of interest in this regard is Lokker NA et al J Biol Chem 1997 Dec 26;272(52):33037-44 which reports an example of an assay to identify antagonists (in this case neutralizing antibodies).

Assays may also be designed to detect the effect of added test compounds on the production of mRNA encoding the polypeptide in cells. For example, an ELISA may be  
20 constructed that measures secreted or cell-associated levels of polypeptide using monoclonal or polyclonal antibodies by standard methods known in the art, and this can be used to search for compounds that may inhibit or enhance the production of the polypeptide from suitably manipulated cells or tissues. The formation of binding complexes between the polypeptide and the compound being tested may then be measured.

25 Assay methods that are also included within the terms of the present invention are those that involve the use of the genes and polypeptides of the invention in overexpression or ablation assays. Such assays involve the manipulation of levels of these genes/polypeptides in cells and assessment of the impact of this manipulation event on the physiology of the manipulated cells. For example, such experiments reveal details of signalling and  
30 metabolic pathways in which the particular genes/polypeptides are implicated, generate information regarding the identities of polypeptides with which the studied polypeptides

interact and provide clues as to methods by which related genes and proteins are regulated.

Another technique for drug screening which may be used provides for high throughput screening of compounds having suitable binding affinity to the polypeptide of interest (see International patent application WO84/03564). In this method, large numbers of different

5 small test compounds are synthesised on a solid substrate, which may then be reacted with the polypeptide of the invention and washed. One way of immobilising the polypeptide is to use non-neutralising antibodies. Bound polypeptide may then be detected using methods that are well known in the art. Purified polypeptide can also be coated directly onto plates for use in the aforementioned drug screening techniques.

10 The polypeptide of the invention may be used to identify membrane-bound or soluble receptors, through standard receptor binding techniques that are known in the art, such as ligand binding and crosslinking assays in which the polypeptide is labelled with a radioactive isotope, is chemically modified, or is fused to a peptide sequence that facilitates its detection or purification, and incubated with a source of the putative receptor  
15 (for example, a composition of cells, cell membranes, cell supernatants, tissue extracts, or bodily fluids). The efficacy of binding may be measured using biophysical techniques such as surface plasmon resonance and spectroscopy. Binding assays may be used for the purification and cloning of the receptor, but may also identify agonists and antagonists of the polypeptide, that compete with the binding of the polypeptide to its receptor. Standard  
20 methods for conducting screening assays are well understood in the art.

The invention also includes a screening kit useful in the methods for identifying agonists, antagonists, ligands, receptors, substrates, enzymes, that are described above.

The invention includes the agonists, antagonists, ligands, receptors, substrates and enzymes, and other compounds which modulate the activity or antigenicity of the  
25 polypeptide of the invention discovered by the methods that are described above.

The invention also provides pharmaceutical compositions comprising a polypeptide, nucleic acid, ligand or compound of the invention in combination with a suitable pharmaceutical carrier. These compositions may be suitable as therapeutic or diagnostic reagents, as vaccines, or as other immunogenic compositions, as outlined in detail below.

30 According to the terminology used herein, a composition containing a polypeptide, nucleic acid, ligand or compound [X] is "substantially free of" impurities [herein, Y] when at least

85% by weight of the total X+Y in the composition is X. Preferably, X comprises at least about 90% by weight of the total of X+Y in the composition, more preferably at least about 95%, 98% or even 99% by weight.

The pharmaceutical compositions should preferably comprise a therapeutically effective amount of the polypeptide, nucleic acid molecule, ligand, or compound of the invention. The term "therapeutically effective amount" as used herein refers to an amount of a therapeutic agent needed to treat, ameliorate, or prevent a targeted disease or condition, or to exhibit a detectable therapeutic or preventative effect. For any compound, the therapeutically effective dose can be estimated initially either in cell culture assays, for example, of neoplastic cells, or in animal models, usually mice, rabbits, dogs, or pigs. The animal model may also be used to determine the appropriate concentration range and route of administration. Such information can then be used to determine useful doses and routes for administration in humans.

The precise effective amount for a human subject will depend upon the severity of the disease state, general health of the subject, age, weight, and gender of the subject, diet, time and frequency of administration, drug combination(s), reaction sensitivities, and tolerance/response to therapy. This amount can be determined by routine experimentation and is within the judgement of the clinician. Generally, an effective dose will be from 0.01 mg/kg to 50 mg/kg, preferably 0.05 mg/kg to 10 mg/kg. Compositions may be administered individually to a patient or may be administered in combination with other agents, drugs or hormones.

A pharmaceutical composition may also contain a pharmaceutically acceptable carrier, for administration of a therapeutic agent. Such carriers include antibodies and other polypeptides, genes and other therapeutic agents such as liposomes, provided that the carrier does not itself induce the production of antibodies harmful to the individual receiving the composition, and which may be administered without undue toxicity. Suitable carriers may be large, slowly metabolised macromolecules such as proteins, polysaccharides, polylactic acids, polyglycolic acids, polymeric amino acids, amino acid copolymers and inactive virus particles.

Pharmaceutically acceptable salts can be used therein, for example, mineral acid salts such as hydrochlorides, hydrobromides, phosphates, sulphates, and the like; and the salts of organic acids such as acetates, propionates, malonates, benzoates, and the like. A thorough

discussion of pharmaceutically acceptable carriers is available in Remington's Pharmaceutical Sciences (Mack Pub. Co., N.J. 1991).

Pharmaceutically acceptable carriers in therapeutic compositions may additionally contain liquids such as water, saline, glycerol and ethanol. Additionally, auxiliary substances, such as wetting or emulsifying agents, pH buffering substances, and the like, may be present in such compositions. Such carriers enable the pharmaceutical compositions to be formulated as tablets, pills, dragees, capsules, liquids, gels, syrups, slurries, suspensions, and the like, for ingestion by the patient.

Once formulated, the compositions of the invention can be administered directly to the subject. The subjects to be treated can be animals; in particular, human subjects can be treated.

The pharmaceutical compositions utilised in this invention may be administered by any number of routes including, but not limited to, oral, intravenous, intramuscular, intra-arterial, intramedullary, intrathecal, intraventricular, transdermal or transcutaneous applications (for example, see WO98/20734), subcutaneous, intraperitoneal, intranasal, enteral, topical, sublingual, intravaginal or rectal means. Gene guns or hyposprays may also be used to administer the pharmaceutical compositions of the invention. Typically, the therapeutic compositions may be prepared as injectables, either as liquid solutions or suspensions; solid forms suitable for solution in, or suspension in, liquid vehicles prior to injection may also be prepared.

Direct delivery of the compositions will generally be accomplished by injection, subcutaneously, intraperitoneally, intravenously or intramuscularly, or delivered to the interstitial space of a tissue. The compositions can also be administered into a lesion. Dosage treatment may be a single dose schedule or a multiple dose schedule.

If the activity of the polypeptide of the invention is in excess in a particular disease state, several approaches are available. One approach comprises administering to a subject an inhibitor compound (antagonist) as described above, along with a pharmaceutically acceptable carrier in an amount effective to inhibit the function of the polypeptide, such as by blocking the binding of ligands, substrates, enzymes, receptors, or by inhibiting a second signal, and thereby alleviating the abnormal condition. Preferably, such antagonists are antibodies. Most preferably, such antibodies are chimeric and/or humanised to



minimise their immunogenicity, as described previously.

In another approach, soluble forms of the polypeptide that retain binding affinity for the ligand, substrate, enzyme, receptor, in question, may be administered. Typically, the polypeptide may be administered in the form of fragments that retain the relevant portions.

- 5 In an alternative approach, expression of the gene encoding the polypeptide can be inhibited using expression blocking techniques, such as the use of antisense nucleic acid molecules (as described above), either internally generated or separately administered. Modifications of gene expression can be obtained by designing complementary sequences or antisense molecules (DNA, RNA, or PNA) to the control, 5' or regulatory regions
- 10 (signal sequence, promoters, enhancers and introns) of the gene encoding the polypeptide. Similarly, inhibition can be achieved using "triple helix" base-pairing methodology. Triple helix pairing is useful because it causes inhibition of the ability of the double helix to open sufficiently for the binding of polymerases, transcription factors, or regulatory molecules. Recent therapeutic advances using triplex DNA have been described in the literature (Gee, J.E. *et al.* (1994) In: Huber, B.E. and B.I. Carr, Molecular and Immunologic Approaches, Futura Publishing Co., Mt. Kisco, NY). The complementary sequence or antisense molecule may also be designed to block translation of mRNA by preventing the transcript from binding to ribosomes. Such oligonucleotides may be administered or may be generated *in situ* from expression in vivo.
- 15
- 20 In addition, expression of the polypeptide of the invention may be prevented by using ribozymes specific to its encoding mRNA sequence. Ribozymes are catalytically active RNAs that can be natural or synthetic (see for example Usman, N, *et al.*, Curr. Opin. Struct. Biol (1996) 6(4), 527-33). Synthetic ribozymes can be designed to specifically cleave mRNAs at selected positions thereby preventing translation of the mRNAs into
- 25 functional polypeptide. Ribozymes may be synthesised with a natural ribose phosphate backbone and natural bases, as normally found in RNA molecules. Alternatively the ribozymes may be synthesised with non-natural backbones, for example, 2'-O-methyl RNA, to provide protection from ribonuclease degradation and may contain modified bases.
- 30 RNA molecules may be modified to increase intracellular stability and half-life. Possible modifications include, but are not limited to, the addition of flanking sequences at the 5' and/or 3' ends of the molecule or the use of phosphorothioate or 2' O-methyl rather than

phosphodiesterase linkages within the backbone of the molecule. This concept is inherent in the production of PNAs and can be extended in all of these molecules by the inclusion of non-traditional bases such as inosine, queosine and butosine, as well as acetyl-, methyl-, thio- and similarly modified forms of adenine, cytidine, guanine, thymine and uridine  
5 which are not as easily recognised by endogenous endonucleases.

For treating abnormal conditions related to an under-expression of the polypeptide of the invention and its activity, several approaches are also available. One approach comprises administering to a subject a therapeutically effective amount of a compound that activates the polypeptide, i.e., an agonist as described above, to alleviate the abnormal condition.  
10 Alternatively, a therapeutic amount of the polypeptide in combination with a suitable pharmaceutical carrier may be administered to restore the relevant physiological balance of polypeptide.

Gene therapy may be employed to effect the endogenous production of the polypeptide by the relevant cells in the subject. Gene therapy is used to treat permanently the inappropriate  
15 production of the polypeptide by replacing a defective gene with a corrected therapeutic gene.

Gene therapy of the present invention can occur *in vivo* or *ex vivo*. *Ex vivo* gene therapy requires the isolation and purification of patient cells, the introduction of a therapeutic gene and introduction of the genetically altered cells back into the patient. In contrast, *in vivo*  
20 gene therapy does not require isolation and purification of a patient's cells.

The therapeutic gene is typically "packaged" for administration to a patient. Gene delivery vehicles may be non-viral, such as liposomes, or replication-deficient viruses, such as adenovirus as described by Berkner, K.L., in Curr. Top. Microbiol. Immunol., 158, 39-66 (1992) or adeno-associated virus (AAV) vectors as described by Muzyczka, N., in Curr.  
25 Top. Microbiol. Immunol., 158, 97-129 (1992) and U.S. Patent No. 5,252,479. For example, a nucleic acid molecule encoding a polypeptide of the invention may be engineered for expression in a replication-defective retroviral vector. This expression construct may then be isolated and introduced into a packaging cell transduced with a retroviral plasmid vector containing RNA encoding the polypeptide, such that the  
30 packaging cell now produces infectious viral particles containing the gene of interest. These producer cells may be administered to a subject for engineering cells *in vivo* and expression of the polypeptide *in vivo* (see Chapter 20, Gene Therapy and other Molecular

Genetic-based Therapeutic Approaches, (and references cited therein) in Human Molecular Genetics (1996), T Strachan and A P Read, BIOS Scientific Publishers Ltd).

Another approach is the administration of "naked DNA" in which the therapeutic gene is directly injected into the bloodstream or muscle tissue.

- 5 In situations in which the polypeptides or nucleic acid molecules of the invention are disease-causing agents, the invention provides that they can be used in vaccines to raise antibodies against the disease causing agent.

Vaccines according to the invention may either be prophylactic (ie. to prevent infection) or therapeutic (ie. to treat disease after infection). Such vaccines comprise immunising  
10 antigen(s), immunogen(s), polypeptide(s), protein(s) or nucleic acid, usually in combination with pharmaceutically-acceptable carriers as described above, which include any carrier that does not itself induce the production of antibodies harmful to the individual receiving the composition. Additionally, these carriers may function as immunostimulating agents ("adjuvants"). Furthermore, the antigen or immunogen may be conjugated to a  
15 bacterial toxoid, such as a toxoid from diphtheria, tetanus, cholera, H. pylori, and other pathogens.

Since polypeptides may be broken down in the stomach, vaccines comprising polypeptides are preferably administered parenterally (for instance, subcutaneous, intramuscular, intravenous, or intradermal injection). Formulations suitable for parenteral administration  
20 include aqueous and non-aqueous sterile injection solutions which may contain anti-oxidants, buffers, bacteriostats and solutes which render the formulation isotonic with the blood of the recipient, and aqueous and non-aqueous sterile suspensions which may include suspending agents or thickening agents.

The vaccine formulations of the invention may be presented in unit-dose or multi-dose  
25 containers. For example, sealed ampoules and vials and may be stored in a freeze-dried condition requiring only the addition of the sterile liquid carrier immediately prior to use. The dosage will depend on the specific activity of the vaccine and can be readily determined by routine experimentation.

Genetic delivery of antibodies that bind to polypeptides according to the invention may  
30 also be effected, for example, as described in International patent application WO98/55607.

The technology referred to as jet injection (see, for example, [www.powderject.com](http://www.powderject.com)) may also be useful in the formulation of vaccine compositions.

A number of suitable methods for vaccination and vaccine delivery systems are described in International patent application WO00/29428.

- 5 This invention also relates to the use of nucleic acid molecules according to the present invention as diagnostic reagents. Detection of a mutated form of the gene characterised by the nucleic acid molecules of the invention which is associated with a dysfunction will provide a diagnostic tool that can add to, or define, a diagnosis of a disease, or susceptibility to a disease, which results from under-expression, over-expression or altered
- 10 spatial or temporal expression of the gene. Individuals carrying mutations in the gene may be detected at the DNA level by a variety of techniques.

Nucleic acid molecules for diagnosis may be obtained from a subject's cells, such as from blood, urine, saliva, tissue biopsy or autopsy material. The genomic DNA may be used directly for detection or may be amplified enzymatically by using PCR, ligase chain

15 reaction (LCR), strand displacement amplification (SDA), or other amplification techniques (see Saiki *et al.*, Nature, 324, 163-166 (1986); Bej, *et al.*, Crit. Rev. Biochem. Molec. Biol., 26, 301-334 (1991); Birkenmeyer *et al.*, J. Virol. Meth., 35, 117-126 (1991); Van Brunt, J., Bio/Technology, 8, 291-294 (1990)) prior to analysis.

In one embodiment, this aspect of the invention provides a method of diagnosing a disease

20 in a patient, comprising assessing the level of expression of a natural gene encoding a polypeptide according to the invention and comparing said level of expression to a control level, wherein a level that is different to said control level is indicative of disease. The method may comprise the steps of:

- a) contacting a sample of tissue from the patient with a nucleic acid probe under stringent
- 25 conditions that allow the formation of a hybrid complex between a nucleic acid molecule of the invention and the probe;
- b) contacting a control sample with said probe under the same conditions used in step a);
- c) and detecting the presence of hybrid complexes in said samples;

wherein detection of levels of the hybrid complex in the patient sample that differ from

30 levels of the hybrid complex in the control sample is indicative of disease.

A further aspect of the invention comprises a diagnostic method comprising the steps of:

- a) obtaining a tissue sample from a patient being tested for disease;
- b) isolating a nucleic acid molecule according to the invention from said tissue sample; and
- c) diagnosing the patient for disease by detecting the presence of a mutation in the nucleic acid molecule which is associated with disease.

To aid the detection of nucleic acid molecules in the above-described methods, an amplification step, for example using PCR, may be included.

Deletions and insertions can be detected by a change in the size of the amplified product in comparison to the normal genotype. Point mutations can be identified by hybridizing amplified DNA to labelled RNA of the invention or alternatively, labelled antisense DNA sequences of the invention. Perfectly-matched sequences can be distinguished from mismatched duplexes by RNase digestion or by assessing differences in melting temperatures. The presence or absence of the mutation in the patient may be detected by contacting DNA with a nucleic acid probe that hybridises to the DNA under stringent conditions to form a hybrid double-stranded molecule, the hybrid double-stranded molecule having an unhybridised portion of the nucleic acid probe strand at any portion corresponding to a mutation associated with disease; and detecting the presence or absence of an unhybridised portion of the probe strand as an indication of the presence or absence of a disease-associated mutation in the corresponding portion of the DNA strand.

Such diagnostics are particularly useful for prenatal and even neonatal testing.

Point mutations and other sequence differences between the reference gene and "mutant" genes can be identified by other well-known techniques, such as direct DNA sequencing or single-strand conformational polymorphism, (see Orita *et al.*, Genomics, 5, 874-879 (1989)). For example, a sequencing primer may be used with double-stranded PCR product or a single-stranded template molecule generated by a modified PCR. The sequence determination is performed by conventional procedures with radiolabelled nucleotides or by automatic sequencing procedures with fluorescent-tags. Cloned DNA segments may also be used as probes to detect specific DNA segments. The sensitivity of this method is greatly enhanced when combined with PCR. Further, point mutations and other sequence variations, such as polymorphisms, can be detected as described above, for example, through the use of allele-specific oligonucleotides for PCR amplification of sequences that

differ by single nucleotides.

DNA sequence differences may also be detected by alterations in the electrophoretic mobility of DNA fragments in gels, with or without denaturing agents, or by direct DNA sequencing (for example, Myers *et al.*, Science (1985) 230:1242). Sequence changes at  
5 specific locations may also be revealed by nuclease protection assays, such as RNase and S1 protection or the chemical cleavage method (see Cotton *et al.*, Proc. Natl. Acad. Sci. USA (1985) 85: 4397-4401).

In addition to conventional gel electrophoresis and DNA sequencing, mutations such as microdeletions, aneuploidies, translocations, inversions, can also be detected by *in situ*  
10 analysis (see, for example, Keller *et al.*, DNA Probes, 2nd Ed., Stockton Press, New York, N.Y., USA (1993)), that is, DNA or RNA sequences in cells can be analysed for mutations without need for their isolation and/or immobilisation onto a membrane. Fluorescence *in situ* hybridization (FISH) is presently the most commonly applied method and numerous reviews of FISH have appeared (see, for example, Trachuck *et al.*, Science, 250, 559-562  
15 (1990), and Trask *et al.*, Trends, Genet., 7, 149-154 (1991)).

In another embodiment of the invention, an array of oligonucleotide probes comprising a nucleic acid molecule according to the invention can be constructed to conduct efficient screening of genetic variants, mutations and polymorphisms. Array technology methods are well known and have general applicability and can be used to address a variety of  
20 questions in molecular genetics including gene expression, genetic linkage, and genetic variability (see for example: M.Chee *et al.*, Science (1996), Vol 274, pp 610-613).

In one embodiment, the array is prepared and used according to the methods described in PCT application WO95/11995 (Chee *et al.*); Lockhart, D. J. *et al.* (1996) Nat. Biotech. 14: 1675-1680); and Schena, M. *et al.* (1996) Proc. Natl. Acad. Sci. 93: 10614-10619).  
25 Oligonucleotide pairs may range from two to over one million. The oligomers are synthesized at designated areas on a substrate using a light-directed chemical process. The substrate may be paper, nylon or other type of membrane, filter, chip, glass slide or any other suitable solid support. In another aspect, an oligonucleotide may be synthesized on the surface of the substrate by using a chemical coupling procedure and an ink jet  
30 application apparatus, as described in PCT application W095/25116 (Baldeschweiler *et al.*). In another aspect, a "gridded" array analogous to a dot (or slot) blot may be used to arrange and link cDNA fragments or oligonucleotides to the surface of a substrate using a vacuum

system, thermal, UV, mechanical or chemical bonding procedures. An array, such as those described above, may be produced by hand or by using available devices (slot blot or dot blot apparatus), materials (any suitable solid support), and machines (including robotic instruments), and may contain 8, 24, 96, 384, 1536 or 6144 oligonucleotides, or any other  
5 number between two and over one million which lends itself to the efficient use of commercially-available instrumentation.

In addition to the methods discussed above, diseases may be diagnosed by methods comprising determining, from a sample derived from a subject, an abnormally decreased or increased level of polypeptide or mRNA. Decreased or increased expression can be  
10 measured at the RNA level using any of the methods well known in the art for the quantitation of polynucleotides, such as, for example, nucleic acid amplification, for instance PCR, RT-PCR, RNase protection, Northern blotting and other hybridization methods.

Assay techniques that can be used to determine levels of a polypeptide of the present  
15 invention in a sample derived from a host are well-known to those of skill in the art and are discussed in some detail above (including radioimmunoassays, competitive-binding assays, Western Blot analysis and ELISA assays). This aspect of the invention provides a diagnostic method which comprises the steps of: (a) contacting a ligand as described above with a biological sample under conditions suitable for the formation of a ligand-  
20 polypeptide complex; and (b) detecting said complex.

Protocols such as ELISA, RIA, and FACS for measuring polypeptide levels may additionally provide a basis for diagnosing altered or abnormal levels of polypeptide expression. Normal or standard values for polypeptide expression are established by combining body fluids or cell extracts taken from normal mammalian subjects, preferably  
25 humans, with antibody to the polypeptide under conditions suitable for complex formation. The amount of standard complex formation may be quantified by various methods, such as by photometric means.

Antibodies which specifically bind to a polypeptide of the invention may be used for the diagnosis of conditions or diseases characterised by expression of the polypeptide, or in  
30 assays to monitor patients being treated with the polypeptides, nucleic acid molecules, ligands and other compounds of the invention. Antibodies useful for diagnostic purposes may be prepared in the same manner as those described above for therapeutics. Diagnostic

assays for the polypeptide include methods that utilise the antibody and a label to detect the polypeptide in human body fluids or extracts of cells or tissues. The antibodies may be used with or without modification, and may be labelled by joining them, either covalently or non-covalently, with a reporter molecule. A wide variety of reporter molecules known  
5 in the art may be used, several of which are described above.

Quantities of polypeptide expressed in subject, control and disease samples from biopsied tissues are compared with the standard values. Deviation between standard and subject values establishes the parameters for diagnosing disease. Diagnostic assays may be used to distinguish between absence, presence, and excess expression of polypeptide and to  
10 monitor regulation of polypeptide levels during therapeutic intervention. Such assays may also be used to evaluate the efficacy of a particular therapeutic treatment regimen in animal studies, in clinical trials or in monitoring the treatment of an individual patient.

A diagnostic kit of the present invention may comprise:

- (a) a nucleic acid molecule of the present invention;
- 15 (b) a polypeptide of the present invention; or
- (c) a ligand of the present invention.

In one aspect of the invention, a diagnostic kit may comprise a first container containing a nucleic acid probe that hybridises under stringent conditions with a nucleic acid molecule according to the invention; a second container containing primers useful for amplifying the  
20 nucleic acid molecule; and instructions for using the probe and primers for facilitating the diagnosis of disease. The kit may further comprise a third container holding an agent for digesting unhybridised RNA.

In an alternative aspect of the invention, a diagnostic kit may comprise an array of nucleic acid molecules, at least one of which may be a nucleic acid molecule according to the  
25 invention.

To detect polypeptide according to the invention, a diagnostic kit may comprise one or more antibodies that bind to a polypeptide according to the invention; and a reagent useful for the detection of a binding reaction between the antibody and the polypeptide.

Such kits will be of use in diagnosing a disease or susceptibility to disease, including, but  
30 not limited to, diseases including, but not limited to, cell proliferative disorders,



autoimmune/inflammatory disorders, cardiovascular disorders, neurological and psychiatric disorders, developmental disorders, genetic disorders, metabolic disorders, infections and other pathological conditions. These diseases preferably include neoplasm, cancer, brain tumour, glioma, bone tumor, lung tumor, breast tumour, prostate tumour, colon tumour, hemangioma, myeloproliferative disorder, leukemia, hematological disease, neutropenia, thrombocytopenia, angiogenesis disorders, dermatological disease, ageing, wounds, burns, fibrosis, cardiovascular disease, restenosis, heart disease, peripheral vascular disease, coronary artery disease, oedema, thromboembolism, dysmenorrhea, endometriosis, pre-eclampsia, lung disease, COPD, asthma bone disease, renal disease, glomerulonephritis, skin disease, liver disease, Crohn's disease, gastritis, ulcerative colitis, ulcer, immune disorder, autoimmune disease, arthritis, rheumatoid arthritis, psoriasis, epidermolysis bullosa, systemic lupus erythematosus, ankylosing spondylitis, Lyme disease, multiple sclerosis, neurodegeneration, stroke, brain/spinal cord injury, Alzheimer's disease, Parkinson's disease, motor neurone disease, neuromuscular disease, HIV, AIDS, cytomegalovirus infection, fungal infection, ocular disorder, macular degeneration, glaucoma, diabetic retinopathy, ocular hypertension and other conditions in which immunoglobulin domain containing cell recognition molecules are implicated.

Various aspects and embodiments of the present invention will now be described in more detail by way of example, with particular reference to the INSP052 and INSP055 polypeptides.

It will be appreciated that modification of detail may be made without departing from the scope of the invention.

### **Brief description of the Figures**

**Figure 1:** (A) Multiple alignment generated by CLUSTALW of the full-length INSP052 polypeptide sequence, the mature, isolated extracellular domain INSP052 (INSP052EC), and the closest related sequence identified in WO04/009834 (SEQIDNO434 and SEQIDNO880). (B) Multiple alignment generated by CLUSTALW comparing INSP052EC with the corresponding histidine tagged (INSP052EC-6His) and Fc fusion (INSP052EC-FC) versions of this sequence and with the Ig-domain-containing fragment of INSP052 (INSP052Ig2). The Fc sequence corresponds to amino acids 246-477 of the constant region

of human immunoglobulin lambda heavy chain IgG1; NCBI Acc. No. CAA75302. Underlined sequence denotes predicted signal peptide. Boxed sequence denotes predicted transmembrane domain. “ \* ” indicates identical residues amongst the aligned sequences. “ : ” indicates homologous residues amongst the aligned sequences.

- 5 **Figure 2:** % of secreted TNF-alpha (TNF-a) by ConA-stimulated hPBMC mixed with serially diluted preparations of INSP052EC-6His (expressed in dilution of the protein preparation; see Example 4). The two curves (interpolating either crosses or circles) represent the results obtained with two different lots of the protein.

- Figure 3:** % secreted IL-4 (Interleukin 4) by ConA-stimulated hPBMC mixed with serially  
10 diluted preparations of INSP052EC-6His (expressed in dilution of the protein preparation; see Example 4). The two curves (interpolating either crosses or circles) represent the results obtained with two different lots of the protein.

- Figure 4:** % secreted IL-2 (Interleukin 2) by ConA-stimulated hPBMC mixed with serially  
15 diluted preparations of INSP052EC-6His (expressed in dilution of the protein preparation; see Example 4). The two curves (interpolating either crosses or circles) represent the results obtained with two different lots of the protein.

- Figure 5:** inhibition of IL-5 (Interleukin 5; A) and IL-2 (Interleukin 2; B) secretion ConA-stimulated hPBMC mixed with increasing amount of INSP052EC-6His (expressed in log of the concentration of the protein in µg/ml). The IC50 value is indicated by the line  
20 interpolating the curve and the X/Y axis.

- Figure 6:** inhibition of IL-5 (Interleukin 5; A) and IL-2 (Interleukin 2; B) secretion by ConA-stimulated purified CD4+ T cells mixed with increasing amount of INSP052EC-6His (expressed in µg/ml). The effect can be compared to the values of cytokine secretion in presence or absence of ConA (YES, NO), and in presence of both ConA and  
25 Dexamethasone (Dex; 0.1 mg/kg).

**Figure 7:** INSP052EC-electrotransferred animals (pDEST12.2 INSP052-6HIS) show a decrease of the blood levels of transaminases alanine aminotransferase (ALAT; A) and aspartate aminotransferase (ASAT; B) as compared to empty vector (pDEST12.2 ) control

animals and human IL6-electrotransferred animals (pDEST12.2 hIL6-SII) 8 hours after the ConA challenge (see Example 6). The asterisks indicate the level of statistical significance of the decrease (the more asterisks, the more significant the decrease).

**Figure 8:** TNF-alpha and IL-6 cytokine levels in INSP052EC-6His- and hIL6-SII-electrotransferred animals (see Example 6 and Figure 7).

**Figure 9:** Effect of INSP052EC-6His administered in two dosages in mice then exposed to ConA. The blood levels of ASAT (A) and ALAT (B) were measured after 8 hours from ConA injection (see Example 6).

**Figure 10:** Effect of INSP052EC-6His injection prior to LPS administration on the release in the blood of IL-6 (A) or TNF alpha (B). The mice were treated with the protein at indicated concentration, with Dexamethasone (Dex; 0.1 mg/kg), or with the injection vehicle only (see Example 7). The asterisks indicate the level of statistical significance of the decrease (see Figure 7).

**Figure 11:** Effect of HEK293 cells transiently expressing INSP052EC-6His on the LPS-induced release in the blood of TNF alpha. The mice were treated with the indicated volume of encapsulated cells expressing INSP052EC-6His, or with control cells (HEK) with or without Dexamethasone (Dex; 0.1 mg/kg) (see Example 7). The asterisks indicate the level of statistical significance of the decrease (see Figure 7).

**Figure 12:** Effect of INSP052EC-6His injection prior to LPS administration on the release in the blood of IL-6 (A) or TNF alpha (B). The mice were treated with the protein at indicated concentration, with Dexamethasone (Dex; 0.1 mg/kg), or with the injection vehicle only (see Example 8). The asterisks indicate the level of statistical significance of the decrease (see Figure 7).

## **EXAMPLES**

### **Example 1: INSP052 and INSP055 sequences**

The polypeptide sequence derived from combining SEQ ID NO:2, SEQ ID NO:4, SEQ ID NO:6, SEQ ID NO:8, SEQ ID NO:10, SEQ ID NO:12 and SEQ ID NO:14 and SEQ ID NO:16 which represents the translation of consecutive exons from INSP052 is derived from

human genomic DNA sequence. The polynucleotide and polypeptide sequences SEQ ID NO: 17 and SEQ ID NO: 18 representing INSP055 are polynucleotide and polypeptide sequences of the mouse orthologue of INSP052 respectively. INSP052 and INSP055 polypeptide sequences represented by SEQ ID NO 16 and SEQ ID NO 18, respectively, are predicted to  
5 contain signal peptide sequences and a transmembrane spanning domain. In particular, the full and mature sequence of the extracellular domain has been identified at the DNA and protein level (SEQ ID NO: 19-22).

As indicated in WO 03/93316, the INSP052 full length prediction encodes a type I membrane protein of 416 amino acids, related to the VEGF/PDGF receptors, belonging to  
10 the immunoglobulin superfamily. The putative signal sequence consists of amino acids 1-33 of INSP052. The predicted transmembrane (TM) domain consists of amino acids 241-263 of INSP052. Thus the mature extracellular domain of INSP052 consists of amino acids 34-240 of INSP052. This latter sequence is similar to two sequences disclosed in the literature as SEQIDNO434 and SEQIDNO880 (WO 04/009834; SEQ ID NO: 27 and 28).  
15 Variants of INSP052EC (the extracellular domain of mature INSP052; SEQ ID NO: 22) or of the corresponding full extracellular domain (SEQ ID NO: 20) can be generated by fusing heterologous protein sequences at the N- and / or C- terminus of this protein sequence, with the purpose of facilitating protein production, purification, or stability when produced using recombinant DNA technologies. Design of the moieties, ligands, and  
20 linkers, as well methods and strategies for the construction, purification, detection, maturation, and use of fusion proteins are widely discussed in the literature (Nilsson J et al., Protein Expr Purif, 11: 1-16, 1997; "Applications of chimeric genes and hybrid proteins" Methods Enzymol. Vol. 326-328, Academic Press, 2000).

Other examples of such fusion proteins are the ones including signal sequence from  
25 another protein (such as the one human growth hormone or beta2-Microglobulin), a purification tag (such as a Histidine tag or a HA tag), the extracellular domain of a different membrane-bound protein, a secreted protein (such as a cytokine or a serum protein like albumin), a starting Methionine (in order allow the direct expression, for example, in *E. coli*), a linker region containing a recognition site for an endopeptidase  
30 (facilitating the elimination of the heterologous protein sequence), or the Fc region from a human immunoglobulin (Figure 1B).

The choice of one or more of these sequences to be fused to INSP052EC is functional to specific use and/or purification protocol of said protein as recombinant protein. For example, the activity of INSP052EC can be also test tested by means of a fusion protein including an albumin sequence or, as shown in the examples with INSP052EC-6HIS (SEQ  
5 ID NO: 29), a histidine tag sequence facilitating both detection and purification.

Alternatively, fusion proteins comprising INSP052EC can be obtained by linking this sequence to an immunoglobulin domain constant region, a protein domain known to improve the stability and the efficacy of recombinant proteins in the circulation. The resulting fusion protein can be expressed directly by mammalian cells (such as CHO or  
10 HEK293 cells) using the appropriate expression vectors so that the fusion protein is secreted in the culture medium.

Different strategies for generating fusion protein comprising an immunoglobulin fragment are disclosed in the literature (WO 91/08298; WO 96/08570; WO 93/22332; WO 04/085478; WO 02/66514). For example, the nucleic acid sequence encoding the mature  
15 INSP052EC can be cloned in an expression vector fused to a nucleic acid sequence encoding the original INSP052EC signal sequence (or any other appropriate signal sequence) at its 5' end, and the nucleic acid sequence encoding the constant region of human immunoglobulin lambda heavy chain IgG1 (NCBI Acc. No. CAA75302) at its 3' end (SEQ ID NO: 30). The resulting vector can be used to transform a CHO or HEK293  
20 cell line and the clones stably expressing and secreting the recombinant fusion protein having INSP052EC at the N-terminus and the IgG1 sequence at the C-terminus can be selected. This clone then can be used for scaling up the production and for purifying the recombinant fusion protein from the culture medium. Alternatively, the position of the nucleic acid encoding the constant region of human immunoglobulin lambda heavy chain  
25 IgG1 and INSP052EC can be inversed, and the resulting protein can be expressed and secreted using still the original signal sequence of INSP052, or any other appropriate signal sequence.

Other protein sequences allowing the multimerization of INSP052EC are domains isolated from proteins such hCG (WO 97/30161), collagen X (WO 04/33486), C4BP (WO  
30 04/20639), Erb proteins (WO 98/02540), or coiled coil peptides (WO 01/00814).

The additional sequence include in these fusion proteins may be eliminated at the end of its purification or in vivo, if needed, by means of an appropriate endo-/ exopeptidase. For

example, the linker sequence included in the recombinant protein may present a recognition site for an endopeptidase (such as a caspase) that can be used to detach enzymatically the desired protein from the heterologous sequence either in vivo or in vitro. Alternatively, if the protein sequence to be expressed does not contain a starting methionine  
5 (for example, if the sequence encodes for only the mature sequence of the protein, without the signal peptide), a protein of the Invention can be expressed correctly in a host cell with a starting Methionine. This additional amino acid may be then either maintained in the resulting recombinant protein, or eliminated by means of an exopeptidase, such as Methionine Aminopeptidase, according to methods disclosed in the literature (Van  
10 Valkenburgh HA and Kahn RA, Methods Enzymol., 344:186-193, 2002; Ben-Bassat A, Bioprocess Technol., 12:147-59, 1991).

#### **Example 2: Cloning of the INSP052 extracellular domain**

The DNA encoding the entire extracellular region of INSP052 (amino acids 1-240) was cloned by exon assembly from human genomic DNA as described in WO 03/093316. The  
15 protein was then expressed and purified as a Histidine tagged fusion protein (INSP052EC-6His; SEQ ID NO: 29).

#### **Example 3: Expression in mammalian cells of the His-tagged version of INSP052 extracellular domain (INSP052EC-6His-V1 plasmid)**

20 The construction of the expression vector for the His-tagged version of INSP052 extracellular domain (INSP052EC-6His-V1), the transfection of the construct for transfecting Human Embryonic Kidney 293 cells expressing the Epstein-Barr virus Nuclear Antigen (HEK293-EBNA, Invitrogen), and the purification of the recombinant protein INSP052EC-6His was performed as described in WO 03/93316. This protein was  
25 then used for a series of functional tests.

#### **Example 4: Cytokine expression modulation assays using human PBMCs**

##### **4.1: Introduction**

The following *in vitro* cell-based assays measure the effects of INSP052EC (cloned  
30 extracellular domain of INSP052) that was expressed in a Histidine-tagged version to facilitate its purification (INSP052EC-6His; see Examples 2 and 3), on cytokine secretion

induced by different stimuli on human peripheral blood mononuclear cells (hPBMC) cells. Cytokine bead array (CBA) assays were established for IL-2, IFN- $\gamma$ , TNF- $\alpha$ , IL-5, IL-4 and IL-10. In particular, proteins were used initially at 3 different concentrations, and 3 different time points were considered for each concentration –(24, 48, and 72 hours after stimulation).

The best conditions are 100 000 cells/well in 96-well plates and 100 $\mu$ l final in 2 % glycerol (MERCK). The optimal concentration was 5 ng/ml for ConA. The optimal time for the assay is 48 hours. The optimal concentration of the inhibitor of cytokine secretion / expression (positive control), dexamethasone, is 10<sup>-6</sup> M. The optimal concentration of the stimulator of cytokine secretion / expression (negative control), human Interleukin 18 (hIL-18), is 100ng/ml.

#### 4.2: Purification of Human PBMC from a buffy coat

The buffy coat was diluted 1 to 2 with DMEM (GIBCO). 25 ml of diluted blood was thereafter slowly added onto a 15 ml layer of Ficoll (PHARMACIA) in a 50 ml Falcon tube, and tubes were centrifuged (2000 rpm, 20 min, at RT without brake). The interphase (ring) was then collected and the cells were washed with 25 ml of DMEM followed by a centrifuge step (1200 rpm, 5 min). This procedure was repeated three times. A buffy coat gave approximately 600 x 10<sup>6</sup> total cells.

#### 4.3: Screening

80  $\mu$ l of 1.25 x 10<sup>6</sup> cells/ml were diluted in DMEM (GIBCO) +2.5% Human Serum (type AB SIGMA) +1% L-Glutamine (GIBCO) +1% Penicillin-Streptomycin (GIBCO) and thereafter added to a 96 well microtiter plate (NUNC, COSTAR).

10 $\mu$ l were added per well (one condition per well): Proteins were diluted in PBS+20%Glycerol (the final dilution of the proteins is 1/10). The assay was conducted in replica and using serial dilution of the protein. 10 $\mu$ l of the ConA 50 $\mu$ g/ml (the final concentration of ConA is 5 $\mu$ g/ml) were then added per well (one condition per well).

For further clarification the Table below shows the experimental design.

	1	2	3	4	5	6	7	8	9	10	11	12
A	Medium	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Medium
B	Medium	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Medium
C	STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	STIM
D	STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	STIM
E	STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	STIM
F	STIM+ dexa 10-6M	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	STIM+ IL-18 100ng/ml
G	STIM+ dexa 10-6M	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	STIM+ IL-18 100ng/ml
H	STIM+ dexa 10-6M	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	Prot +STIM	STIM+ IL-18 100ng/ml

STIM indicates ConA (5µg/ml); Prot indicates INSP052EC-6His; Dexa is Dexamethasone; IL-18 is human Interleukin 18.

#### 5 4.4: CBA analysis

After 48 hours, cell supernatants were collected and human cytokines were measured by Human Th1/Th2 Cytokine CBA Kit (Becton-Dickinson).

##### i) Preparation of mixed Human Th1/Th2 Capture Beads

The number of assay tubes that were required for the experiment was determined.

- 10 Each capture bead suspension was vigorously vortexed for a few seconds before mixing. For each assay to be analysed, 10µl aliquot of each capture bead were added into a single tube labelled "mixed capture beads". The Bead mixture was thoroughly vortexed.

##### ii) Preparation of test samples

- Supernatants were diluted (1:4) using the Assay Diluent (20µl of supernatants + 60µl of Assay Diluent). The sample dilution was then mixed before transferring samples into a 96 wells microtiter plate conical bottom (Nunc).
- 15

##### iii) Human Th1/Th2 Cytokine CBA Assay Procedure

50µl of the diluted supernatants were added into a 96 wells microtiter plate conical bottom (Nunc). 50µl of the mixed capture beads were added followed by 50µl addition of the



Human Th1/Th2 PE Detection Reagent. The plate was then incubated for 3 hours at RT and protected from direct exposure to light followed by centrifugation at 1500rpm for 5 minutes. The supernatant was then carefully discarded. In a subsequent step, 200µl of wash buffer were twice added to each well, centrifuged at 1500rpm for 5 minutes and  
5 supernatant carefully discarded. 130µl of wash buffer were thereafter added to each well to resuspend the bead pellet. The samples were finally analysed on a flow cytometer (Becton-Dickinson). The data were analysed using the CBA Application Software, Activity Base and Microsoft Excel software.

#### 4.5: Results

- 10 As shown in Figures 2, 3 and 4, INSP052EC-6His was able to down-regulate in a dose-dependent manner the secretion of cytokines (for example TNF-alpha, IL-4 and IL-2) from ConA-stimulated hPBMC using two different lots of the protein. These results confirm a potential therapeutic efficacy of INSP052EC in the treatment of anti-inflammatory and auto-immune diseases.
- 15 A more detailed analysis was performed by calculating the dose-response effect on cytokine secretion in terms of IC50, that is the concentration of INSP052EC-6His needed to reduce the secretion of the cytokine (calculated in pg/ml) down to 50% of the maximal value observed. The resulting curves of inhibition (as exemplified for IL-5 and IL-2 in figure 5), demonstrate that INSP052EC-6His is active as a cytokine antagonist, and in  
20 particular as inhibitor of cytokine secretion and/or expression, in a concentration range of µg/ml: TNF-alpha (IC50: 6-10 µg/ml), IFN-γ (IC50: 3-9 µg/ml), IL-2 (IC50: 12-14 µg/ml), IL-4 (IC50: 14 µg/ml), IL-10 (IC50:10-15 µg/ml) and IL-5 (IC50: 18 µg/ml).

#### Example 5: Cytokine expression modulation assays using human T cells

##### 25 5.1: Materials & methods:

Sub-populations of leukocytes were prepared using MACS cell isolation kit (Miltenyl Biotec) according to the manufacturer's instructions. hPBMC were isolated from buffy coats as described in Example 4. Care was taken to ensure a single-cell suspension. For preparation of CD4+ T cells the CD4+ T Cell Isolation Kit II was used (catalogue number  
30 130-091-155). PBMC were counted, centrifuged for 10 minutes and re-suspended in cold PBS buffer (phosphate buffered saline pH 7.2, supplemented with 0.5% bovine serum

albumin, BSA, and 2mM EDTA) at a concentration of  $2.5 \times 10^8$  cells per ml (40  $\mu$ l of buffer per  $10^7$  cells). 10  $\mu$ l of Biotin-Antibody Cocktail (supplied with the kit) per  $10^7$  total cells was added. The suspension was mixed well and incubated at 4-8 °C for 10 minutes. 30  $\mu$ l of buffer was added per  $10^7$  cells followed by 20  $\mu$ l of Anti-Biotin  
5 MicroBeads per  $10^7$  total cells. The suspension was mixed well and incubated for an additional 15 minutes at 4-8 °C. The cells were washed with buffer by adding 10-20 fold the labeling volume and centrifuged at 300xg for 10 minutes. The supernatant was removed completely and the cells re-suspended up to  $10^8$  cells in 500ul of buffer. Magnetic separation was carried out with an autoMACS™ Separator. The autoMACS™  
10 Separator was prepared and primed according to the manufacturer's instructions. The tube containing the magnetically labeled cells was placed in the autoMACS™ Separator and the program "deplete" was chosen. The negative fraction was collected (outlet port "neg1"). This fraction represents the enriched CD4+ T cells. Where required, the positive fraction was subsequently collected (outlet port "pos1"). This fraction represents the magnetically  
15 labeled non-CD4+ T cells.

The screening and the CBA assays were performed as described above for hPBMC.

## 5.2: Results

The decrease in cytokine secretion from hPBMC induced by INSP052EC-6His was also observed in purified CD4+ T cells following stimulation with ConA. The effects on the  
20 secretion of cytokines were consistent with the ones measured in hPBMC, proportional to the amount of protein added in the sample, and comparable with the reduction observed with a common anti inflammatory compound (Fig. 6).

## Example 6: Mouse model of fulminant liver hepatitis

### 25 6.1: Introduction

Since INSP052EC protein (expressed in the recombinant form INSP052EC-6His) has been shown *in vitro* to inhibit secretion of various cytokines by ConA-stimulated human peripheral blood mononuclear cells (hPBMC; see Example 4), as well as in CD4+ T cells (Example 5), it has been decided to test the activity of INSP052EC in the *in vivo* ConA  
30 model by electrotransfer.

## 6.2: Background - Concanavalin A (ConA)-induced liver hepatitis

Toxic liver disease represents a worldwide health problem in humans for which pharmacological treatments have yet to be discovered. For instance active chronic hepatitis leading to liver cirrhosis is a disease state, in which liver parenchymal cells are progressively destroyed by activated T cells. ConA-induced liver toxicity is one of three experimental models of T-cell dependent apoptotic and necrotic liver injury described in mice. Gal N (D-Galactosamine) sensitized mice challenged with either activating anti-CD3 monoclonal AB or with superantigen SEB develop severe apoptotic and secondary necrotic liver injury (Kusters S, Gastroenterology. 1996 Aug;111(2):462-71). Injection of the T-cell mitogenic plant lectin ConA to non sensitized mice results also in hepatic apoptosis that preceeds necrosis. ConA induces the release of systemic TNF-alpha and IFN-gamma and various other cytokines. Both TNF-alpha and IFN-gamma are critical mediators of liver injury. Transaminase release 8 hours after the insult indicates severe liver destruction.

Several cell types have been shown to be involved in liver damage, CD4 T cells, macrophages and natural killer cells (Kaneko J Exp Med 2000, 191, 105-114). Anti-CD4 antibodies block activation of T cells and consequently liver damage (Tiegs et al. 1992, J Clin Invest 90, 196-203). Pre-treatment of mice with monoclonal antibodies against CD8 failed to protect, whereas deletion of macrophages prevented the induction of hepatitis.

The present study was undertaken to investigate the role of INSP052EC, a TNF-alpha / IL-4 cytokines antagonist protein containing IgG-like domains, in ConA-induced liver hepatitis. Several cytokines have been shown either to be critical in inducing or in conferring protection from ConA-induced liver damage. TNF-alpha for example is one of the first cytokines produced after ConA injection and anti-TNF-alpha antibodies confer protection against disease (Seino et al. 2001, Annals of surgery 234, 681-688). IFN-gamma appears also to be a critical mediator of liver injury, since anti-IFN-gamma antiserum significantly protect mice, as measured by decreased levels of transaminases in the blood of ConA-treated animals (see Kusters et al., above). In liver injury, increased production of IFN-gamma was observed in patients with autoimmune or viral hepatitis. In addition transgenic mice expressing IFN-gamma in the liver develop liver injury resembling chronic active hepatitis (Toyonaga et al. 1994, PNAS 91, 614-618). IFN-gamma may also be cytotoxic to hepatocytes, since *in vitro* IFN-gamma induces cell death in mouse

hepatocytes that was accelerated by TNF alpha (Morita et al. 1995, Hepatology 21, 1585-1593).

Other molecules have been described to be protective in the ConA model. A single administration of rhIL-6 (recombinant human Interleukin 6) completely inhibited the  
5 release of transaminases (Mizuhara et al. 1994, J. Exp. Med. 179, 1529-1537).

### 6.3: cDNA electrotransfer into muscle fibers in order to achieve systemic expression of a protein of interest (INSP052EC)

Among the non-viral techniques for gene transfer *in vivo*, the direct injection of plasmid DNA into the muscle and subsequent electroporation is simple, inexpensive and safe. The  
10 post-mitotic nature and longevity of myofibers permits stable expression of transfected genes, although the transfected DNA does not usually undergo chromosomal integration (Somieri et al. 2000, Molecular Therapy 2,178-187). Several reports have demonstrated that secretion of muscle-produced proteins into the blood stream can be achieved after electroporation of corresponding cDNAs (Aihara H and Miyazaki J, 1998, Nature Biotech  
15 16, 867-870). In addition *in vivo* efficacy of muscle expressed EPO and IL-18BP in disease models has been shown (Rizzuto et al., 2000, Human Gene Therapy 41, 1891-1900; Mallat Z et al., 2001, Circulation Research 89, E41-45).

### 6.4: Materials and Methods

#### 6.4.1: Animals

20 In all the studies male C57/BL6 male (8 weeks of age) were used. In general, 7 animals per experimental group are used. Mice were maintained in standard conditions under a 12-hour light-dark cycle, provided irradiated food and water *ad libitum*.

#### 6.4.2: Muscle Electrotransfer

##### 6.4.2.1: Choice of vector

25 StrepII-tagged human IL6 (hIL6-SII) and INSP052EC-6His genes were cloned in distinct Gateway compatible pDEST12.2 vectors , wherein the protein expression is under the control of the CMV promoter.

##### 6.4.2.2: Electroporation Protocol

Mice were anesthetized with gas (isofluran Baxter, Ref: ZDG9623). Hindlimbs were  
30 shaved and an echographic gel was applied. Hyaluronidase was injected in the posterior

tibialis muscle with (20U in 50µl sterile NaCl 0.9% , Sigma Ref. H3631). After 10 minutes, 100 µg of plasmid (50 µg per leg in 25µl of sterile NaCl 0.9%) was injected in the same muscle. The DNA was prepared in the Buffer PBS-L-Glutamate (6mg/ml; L-Glutamate Sigma P4761) before intramuscular injection. For electrotransfer, the electric field was applied for each leg with the ElectroSquarePorator BTX ref ECM830 at 75 Volts during 20ms for each pulse, 10 pulses with an interval of 1 second in a unipolar way with 2 round electrodes (size 0.5mm diameter).

#### 6.4.3: The ConA Model

##### 6.4.3.1: ConA i.v. injection and blood sampling

8 weeks old Female Mice C57/Bl6 were purchased from IFFA CREDO. ConA (Sigma ref.C7275) was injected at 18mg/kg i.v., and blood samples were taken at 1.30 and 8 hours post-injection. At the time of sacrifice, blood was taken from the heart.

##### 6.4.3.2: Detection of cytokines and transaminases in blood samples

IL2, IL5, IL4, TNF-alpha and IFN-gamma cytokine levels were measured using the TH1/TH2 CBA assay. TNF-alpha, IL-6, MCP1, IFN-alpha, IL-10 and IL-12 were detected using the Inflammation CBA assay. Transaminase (ALAT and ASAT) blood parameters were determined using the COBAS instrument (Hitachi).

##### 6.4.3.3: Electrotransfer of the vectors expressing human INSP052EC-6His and hIL-6-SII

At day 0 electrotransfer of pDEST12.2.-INSP052EC, pDEST12.2-hIL-6 as well as and the empty vector control (electrotransfer protocol see above) was performed. At day 5 after electrotransfer, ConA (18 mg/kg) was injected i.v. and blood sampled at 2 time points (1.30, 8 hours).

##### 6.4.3.4: INSP052 and IL6 protein pretreatment in the ConA model

CHO cell produced, recombinant hIL-6 or HEK293 cell produced, recombinant INSP052-6His was injected s.c. 30 minutes before ConA injection.

#### 6.5: Results

We have shown previously (see Examples 4 and 5; Figures 2-6) that HEK 293 cell expressed INSP052EC-6His protein down-regulates TNF-alpha and IL-4 secretion (amongst other cytokines) in ConA stimulated hPBMC *in vitro* in a dose dependent way.

Since these two cytokines play a crucial role in T cell induced ConA induced liver hepatitis, we tested INSP052EC cDNA and protein in this model.

- INSP052EC-6His protects from liver injury in a mouse model mimicking fulminant hepatitis after systemic delivery of the protein using electrotransfer. Figure 7 show that
- 5 INSP052EC-6His -electrotransferred animals show a decrease in transaminase levels as compared to empty vector control animals 8 hours after the ConA challenge. In addition both TNF-alpha and IL-6 cytokine levels are significantly reduced in these animals (Figure 8). Please note that the effect is similar, or even more important, to that obtained with the positive control vector pDEST12.2hIL-6-SII (Figures 7 and 8).
- 10 The protective effect of INSP052EC-6His was tested also by administering the purified recombinant protein before the injection of ConA. When s.c. injected, INSP052EC protein (1 mg/kg, or 0.3 mg/kg) decreased significantly ASAT and ALAT levels 8 hours after ConA injection (Figure 9).

#### 6.6: Conclusion

- 15 Our experiments have already shown, that INSP052EC downregulates the secretion and/or expression of cytokines such as TNF-alpha, IL-4 and IL-2 *in vitro* in the ConA stimulated hPBMC assay. In addition, the delivery of INSP052EC cDNA in an *in vivo* model of fulminant hepatitis decreases TNF-alpha and m-IL-6 levels in serum and had a significant effect on the reduction of transaminases measured in serum, which was confirmed by s.c.
- 20 INSP052EC protein injections.

- The decrease in ASAT and ALAT levels might be due to both, decreased TNF-alpha and IL-4 levels. TNF-alpha and IL-4 are important cytokines involved in the liver damage after ConA injection. In this mouse model of liver hepatitis TNF-alpha is mainly produced by hepatic macrophages, the so-called Kupfer cells, whereas IL-4 is produced by liver (natural
- 25 killer T) NKT cells. Anti TNF-alpha antibodies confer protection against disease (Seino et al. 2001, Annals of surgery 234, 681-688) and inhibition of IL-4 production by NKT cells was shown to be hepato-protective in T-cell mediated hepatitis in mouse (Ajuebor et al. 2003 J. Immunology 170, 5252-9).

- INSP052EC might be useful in treating auto-immune, viral or acute liver diseases as well
- 30 as alcoholic liver failures. It might be also effective in other inflammatory diseases.

### **Example 7: Cytokine expression modulation properties of INSP052EC-6His in LPS-induced cytokine release in mice**

#### **7.1: Introduction**

The ability of INSP052EC to protect from the effects of cytokine release *in vivo* has been  
5 also tested by injecting either the recombinant protein or encapsulated, transiently  
transfected HEK293 cells expressing INSP052EC-6His in the model of LPS-induced TNF  
alpha and IL-6 release in mice.

Encapsulation of cells expressing a recombinant protein allows understanding of the  
possible therapeutic effects of a continuous administration of the protein *in vivo*, as shown  
10 with proteins with tumor suppressor function; for example (Visted T et al., 2003, Hum  
Gene Ther., 14, 1429-40).

LPS (Lipopolysaccharides) are an important component of the outer membranes of gram-  
negative bacteria and are the best characterised example of innate recognition that leads to  
a robust inflammatory response by macrophages or microglia cells via its binding to CD14  
15 and the Toll receptor 4 (Lehnardt S et al., 2002, J Neurosci., 22, 2478-2486). LPS are  
widely used in literature to activate various cell types like macrophages, microglia and  
endothelial cells, in particular in relationship to liver diseases (Jirillo E et al., 2002, J  
Endotoxin Res., 8, 319-327).

#### **7.2: Materials & Methods**

##### **20 7.2.1: Encapsulation of transiently transfected HEK293 cells expressing INSP052EC-6His**

###### **7.2.1.1: Cell maintenance**

Human Embryonic Kidney 293 cells expressing the Epstein-Barr virus Nuclear Antigen  
(HEK293-EBNA, Invitrogen) were maintained in suspension in Ex-cell VPRO serum-free  
medium (maintenance medium, JRH, UK) supplemented with 4mM L-Glutamine  
25 (Invitrogen) and 1ml/L Phenol-Red-solution (0.5% w/v in water, Phenol Red: Sigma,  
USA) in spinner flasks (Techne, UK).

###### **7.2.1.2: Cell transfection**

At the day of transfection cells were centrifuged and re-suspended in a spinner vessel  
(DasGip, D) in 250 mL DMEM / F12 (1:1) medium containing 1% FBS and 4ml/l ITS-X

supplement (seeding medium, all Invitrogen) at a density of  $1 \times 10^6$  cells/ ml. Cells were transfected using the PEI method with a ratio of 2:1 PEI:DNA. In 100 mL seeding medium 500 $\mu$ g of corresponding plasmid (pDEST12.2-INSP052EC) was mixed with 1 mg PEI (Polysciences, USA) and incubated for 10 minutes at room temperature. The mixture was  
5 added to the cell suspension and incubated for 90 minutes at 37°C. After the incubation the cell suspension was centrifuged (200xg, 10 minutes at 4°C) and the cell pellet was re-suspended in 500 ml maintenance medium. Cells were incubated in a humidified atmosphere with 5% CO<sub>2</sub> at 37°C until encapsulation.

#### 7.2.1.3: Cell encapsulation

10 HEK293EBNA cells transfected with pDEST12.2-INSP052EC or not transfected (control cells) were encapsulated into Alginate-poly-L-Lysine-Alginate (APA) capsules using the Inotech research encapsulator (Inotech, CH). Cells were centrifuged (200xg 10min 4°C) and re-suspended in 2 ml washing buffer (all chemicals Inotech, CH). To this suspension a 1.5% alginate solution was slowly added to yield a final cell concentration of  $2.5 \times 10^6$   
15 cells/ml solution. The alginate-cell-suspension was taken up into a syringe (Braun Omnifit, Braun, D), which was connected to the encapsulation machine.

The encapsulation was carried out using the following parameters:

- Syringe Pump: 275 (50ml Syringe) or 456 (20ml Syringe)
- Anode voltage: 1.16kV
- 20 - Vibration frequency: 1943 Hz
- Vibration amplitude: 3

The protocol for encapsulation was the following:

- Polymerisation buffer: 10 minutes (volume 250 ml)
- Poly-L-Lysin: 10 minutes (volume 150 ml)
- 25 - Washing buffer: 1 minute (volume 150 ml)
- Washing buffer: 5 minutes (volume 150 ml)
- 0.03% Alginate: 5 minutes (volume 150 ml)
- Washing buffer: 1 minute (volume 150 ml)
- Depolymerisation buffer: 10 minutes (volume 300 ml)
- 30 - Washing buffer: 1 minute (volume 150 ml)
- Washing buffer: 5 minutes (volume 150 ml)



Medium (Excell-V-Pro): volume 100 ml

All buffers were prepared according to the manufacturer's manual in sterile distilled water under sterile conditions. In the final step of the encapsulation, the capsules were re-suspended in 100 ml maintenance medium and transferred into a sterile spinner vessel  
5 (Dasgip, D). The capsules were incubated in a humidified atmosphere with 5% CO<sub>2</sub> at 37°C overnight or until injection into the animals.

#### 7.2.2: LPS induced cytokine release model *in vivo*

The model of LPS-induced TNF alpha and IL-6 release in mice was set up according to WO98/38179. Briefly, male C57/BL6 or C3H/HeN mice (8 weeks of age; Charles River,  
10 France) were used. In general, 10 animals per experimental group are used. Mice were maintained in standard conditions under a 12-hour light-dark cycle, provided irradiated food and water ad libitum.

LPS (O111:B4 (Sigma, Switzerland), 0.3 mg/kg) was injected s.c in mice. Ninety minutes later blood was sampled and plasma TNF alpha was determined using an ELISA kit  
15 (R&D). IL-6 levels were measured after 150 minutes using a commercial available ELISA kit (R&D Duoset ref. DY206). Dexamethasone, the reference compound, was solubilized in PBS and Dexamethasone (0.1 mg/kg, s.c.) was injected 15 minutes prior LPS.

The suspension containing the microcapsules containing HEK293 cells (control cells or cells transiently expressing INSP052EC-6His) was removed from the incubator and left  
20 several minutes in the laminar flow hood to allow the capsules to sediment. The clear supernatant was removed and the concentrated capsules were taken up carefully into a syringe. 700µl capsules were injected slowly i.p. via a 0.7 mm needle (ref 53158.01 Polylabo, CH) per mouse. LPS injection was performed at day 3 after the injection of the capsules.

#### 25 7.3: Results

The potential of INSP052EC to downregulate LPS-induced TNF alpha or IL-6 release in the blood was demonstrated in both models of INSP052EC administration.

The injection of INSP052EC-6His 15 minutes prior to the LPS injection. decreases LPS-induced release of IL-6 (if INSP052EC-6His is administered at least at 0.1 mg/kg) and  
30 TNF alpha (if INSP052EC-6His is administered at least at 1 mg/kg) in a statistically

significant manner, similarly to the reference compound Dexamethasone. Mice injected with the vehicle solution for injection (PBS-BSA with 0.02% glycerol) were used as negative controls (Figure 10).

Similar positive effects were observed when the HEK293 cells transiently expressing  
5 INSP052EC-6His were injected in all the tested capsule volumes (figure 11).

### **Example 8: Properties of INSP052EC-6His in a model of Contact Hypersensitivity**

#### **8.1: Introduction**

INSP052EC was tested on hapten induced contact hypersensitivity (CHS), a murine model  
10 of inflammatory skin disease. CHS is a T cell-mediated inflammation model of the skin that represents a well established model for similar inflammations associated to diseases such allergic contact dermatitis and psoriasis, which are dermatological problems with unmet medical needs related to excessive cytokine production (Nakae S et al., 2003, Int Immunol., 15: 251-260; Gorbachev AV and Fairchild RL, 2001, Crit Rev Immunol., 21:  
15 451-72).

#### **8.2: Material and Methods**

The hapten DNFB (2,4-dinitrofluorobenzene; Sigma Chemical Co.) was diluted in acetone / olive oil (4:1) immediately before use. Mice were sensitized with 30 µl of 0.5% DNFB solution painted to the shaved dorsal skin or left untreated. Mice were challenged five days  
20 later, i.e. CHS was elicited by applying a non-irritant dose of 10 µl of 0.2% DNFB onto both sides of the right ear and the same amount of solvent alone onto the left ear. Ear thickness was monitored at day 6 using a caliper (Mitutoya).

Ear swelling was calculated as

$$((T_6 - T_5) \text{ right ear}) - ((T_6 - T_5) \text{ left ear})$$

25 where T6 and T5 represent values of ear thickness at day 6 and day 5, respectively, after sensitization challenge, respectively. To assure that the observed swelling was due to DNFB specific inflammation rather than non-specific irritation, a non-sensitized but challenged group of mice was included with each experiment.

Mice were treated on Day 5 with an s.c injection of INSP052EC-6His in the indicated  
30 amount, Dexamethasone (1 mg/kg), or PBS only (control group).

### 8.3: Results

We show that INSP052EC reduces ear swelling in significant and dose dependent manner, suggesting a decrease in leukocyte infiltration and of the consequent inflammation (Figure 12), demonstrating that INSP052EC can be useful in treating T cell-mediated inflammation  
5 of the skin, such as allergic contact dermatitis and psoriasis.

The examples clearly show that the isolated extracellular domain of INSP052 (INSP052EC) can be used (as such or as a variant or a fusion protein containing this protein sequence or the full length protein) for modulating cytokine activities, in particular as antagonist of cytokine secretion and/or expression, and may have a therapeutic role in  
10 diseases directly or indirectly related to both innate and adaptive immune responses.

The range of inhibiting activities shown by the tested INSP052EC-based molecule in different cell-based assays and animal models confirms that patho-physiological effects of cytokines resulting from their excessive or inappropriately localized production can be blocked by using this molecule. The control of cellular events associated to prolonged  
15 production of proinflammatory cytokines can be obtained by INSP052EC-based molecules, which therefore can be used for antagonizing abnormal inflammatory states associated, in particular, to autoimmune and inflammatory diseases affecting various tissues and organs (e.g. liver, skin, lungs, central nervous system), providing as well a new therapeutic opportunity for oncological, neurological, cardiovascular, and infectious  
20 disorders. Additional clinical applications for INSP052EC-based molecules can be identified by using cytokine assays showing the excessive expression and / or secretion of cytokines in samples obtained by patients affected by other diseases (Wong CK and Lam CW, Adv Clin Chem. 2003, 37:1-46; Whiteside TL, Biotechniques, 2002, Oct. Suppl:4-8, 10, 12-5), then justifying the therapeutic use of a cytokine antagonist as INSP052EC-  
25 based molecules.

## Sequence Information

Note: for amino acids encoded by exon-exon junctions, the amino acid will be assigned to the more 5' exon.

5 SEQ ID NO 1: (INSP052 Nucleotide sequence exon1)  
 1 ATGAAGAGAG AAAGGGGAGC CCTGTCCAGA GCCTCCAGGG CCCTGCGCCT TGCTCCTTTT  
 61 GTCTACCTTC TTCTGATCCA GACAG

10 SEQ ID NO 2: (INSP052 polypeptide sequence of Exon 1)  
 1 MKRERGALSR ASRALRLAPF VYLLLIQTD

15 SEQ ID NO 3: (INSP052 Nucleotide sequence exon2)  
 1 ACCCCCTGGA GGGGGTGAAC ATCACCAGCC CCGTGCGCCT GATCCATGGC ACCGTGGGGA  
 61 AGTCGGCTCT GCTTCTGTG CAGTACAGCA GTACCAGCAG CGACAGGCCT GTAGTGAAGT  
 121 GGCAGCTGAA GCGGGACAAG CCAGTGACCG TGGTGCACTC CATGGCACA GAGGTCATCG  
 181 GCACCTGCG GCCTGACTAT CGAGACCCTA TCCGACTCTT TGAAAATGGC TCCCTGCTTC  
 241 TCAGCGACCT GCAGCTGGCC GATGAGGGCA CCTATGAGGT CGAGATCTCC ATCACCAGACG  
 301 ACACCTTAC TGGGGAGAAG ACCATCAACC TTA CTGTAGA TG

20 SEQ ID NO 4: (INSP052 Protein Sequence of Exon 2)  
 1 PLEGVNITSP VRLIHGTGK SALLSVQYSS TSSDRPVVKW QLKRDKPVTV VQSIGTEVIG  
 61 TLRPDYRDR RLFENGSLLL SDLQLADEGT YEVEISITDD TFTGEKTINL TVDV

25 SEQ ID NO 5: (INSP052 Nucleotide sequence Exon3)  
 1 TGCCCATTTT GAGGCCACAG GTGTTGGTGG CTTCAACCAC TGTGCTGGAG CTCAGCGAGG  
 61 CCTTCACCTT GAACTGCTCA CATGAGAATG GCACCAAGCC CAGCTACACC TGGCTGAAGG  
 121 ATGGCAAGCC CCTCCTCAAT GACTCGAGAA TGCTCCTGTC CCCCAGACAA AAGGTGCTCA  
 181 CCATCACCCG CGTGCTCATG GAGGATGACG ACCTGTACAG CTGCATGGTG GAGAACCCCA  
 241 TCAGCCAGGG CCGCAGCCTG CCGTGTCAAGA TCACCGTATA CA

30 SEQ ID NO 6: (INSP052 Polypeptide sequence of Exon 3)  
 1 PISRPQVLVA STTVLELSEA FTLNCSHENG TKPSYTWLKD GKPLLNDSRM LLSPDQKVLV  
 61 ITRVLMEDDD LYSCMVENPI SQGRSLPVKI TVYR

35 SEQ ID NO 7: (INSP052 Nucleotide Sequence Exon 4)  
 1 GAAGAAGCTC CCTTTACATC ATCTTGCTTA CAGGAGGCAT CTTCTCCTT GTGACCTTGG  
 61 TGACAGTCTG TGCTGCTGG AAACCTCCA AAAG

40 SEQ ID NO 8: (INSP052 Polypeptide sequence of Exon 4)  
 1 RSSLYIILST GGIFLLVTLV TVCACWKPSK R

45 SEQ ID NO 9: (INSP052 Nucleotide Sequence Exon 5)  
 1 GAAACAGAAG AAGCTAGAAA AGCAAAATC CCTGGAATAC ATGGATCAGA ATGATGACCG  
 61 CCGAAACCA GAAG

50 SEQ ID NO 10: (INSP052 Polypeptide Sequence Exon 5)  
 1 KQKKLEKQNS LEYMDQNDDR LKPEA

55 SEQ ID NO 11: (INSP052 Nucleotide Sequence Exon 6)  
 1 CAGACACCCT CCCTCGAAGT GGTGAGCAGG AACGGAAGAA CCCCATGGCA CTCTATATCC  
 61 TGAAGGACAA G

60 SEQ ID NO 12: (INSP052 Polypeptide Sequence Exon 6)  
 1 DTLPRSGEQE RKNPMALYIL KDK

65 SEQ ID NO 13: (INSP052 Nucleotide Sequence Exon 7)  
 1 GACTCCCCGG AGACCGAGGA GAACCCGGCC CCGGAGCCTC GAAGCGCGAC GGAGCCCGGC  
 61 CCGCCCGGCT ACTCCGTGTC TCCCGCCGTG CCGGCGCGCT CGCCGGGGCT GCCCATCCGC  
 121 TCTGCCCCGC GCTACCCGCG CTCCCGAGCG CGCTCCCGAG CCACCGGCCG GACACACTCG  
 181 TCGCCGCCCA GGGCCCCGAG CTCGCCCGGC CGCTCGCGCA GCGCCTCGCG CACACTGCGG  
 241 ACTGCGGGCG TGCACATAAT CCGCGAGCAA GACGAGGCCG GCCCGGTGGA GATCAGCGCC  
 301 TGA

## SEQ ID NO 14: (INSP052 Polypeptide sequence for exon 7)

1 DSPETEENPA PEPRSATEPG PPGYSVSPAV PGRSPGLPIR SARRYPRSPA RSPATGRTHS  
61 SPPRAPSSPG RSRASRRTL TAGVHIIREQ DEAGPVEISA

## 5 SEQ ID NO :15 (INSP052 Combined Nucleotide sequence exons 1,2,3,4,5,6 and 7)

1 ATGAAGAGAG AAAGGGGAGC CCTGTCCAGA GCCTCCAGGG CCCTGCGCCT TGCTCCTTTT  
61 GTCTACCTTC TTCTGATCCA GACAGACCCC CTGGAGGGGG TGAACATCAC CAGCCCCGTG  
121 CGCCTGATCC ATGGCACCCT GGGGAAGTCG GCTCTGCTTT CTGTGCAGTA CAGCAGTACC  
181 AGCAGCGACA GGCCTGTAGT GAAGTGGCAG CTGAAGCGGG ACAAGCCAGT GACCGTGGTG  
10 241 CAGTCCATTG GCACAGAGGT CATCGGCACC CTGCGGCCTG ACTATCGAGA CCGTATCCGA  
301 CTCTTTGAAA ATGGCTCCCT GCTTCTCAGC GACCTGCAGC TGGCCGATGA GGGCACCTAT  
361 GAGGTCGAGA TCTCCATCAC CGACGACACC TTCACTGGGG AGAAGACCAT CAACCTTACT  
421 GTAGATGTGC CCATTTTCGAG GCCACAGGTG TTGGTGGCTT CAACCACTGT GCTGGAGCTC  
481 AGCGAGGCCT TCACCTTGAA CTGCTCACAT GAGAATGGCA CCAAGCCCAG CTACACCTGG  
15 541 CTGAAGGATG GCAAGCCCCCT CCTCAATGAC TCGAGAATGC TCCTGTCCCC CGACCAAAAG  
601 GTGCTCACCA TCACCCGCGT GCTCATGGAG GATGACGACC TGTACAGCTG CATGGTGGAG  
661 AACCCCATCA GCCAGGGCCG CAGCCTGCCT GTCAAGATCA CCGTATACAG AAGAAGCTCC  
721 CTTTACATCA TCTTGTCTAC AGGAGGCATC TTCTCTCTTG TGACCTTGGT GACAGTCTGT  
781 GCCTGCTGGA AACCTCCAA AAGGAAACAG AAGAAGCTAG AAAAGCAAAA CTCCCTGGAA  
20 841 TACATGGATC AGAATGATGA CCGCCTGAAA CCAGAAGCAG ACACCTCCC TCGAAGTGGT  
901 GAGCAGGAAC GGAAGAACCC CATGGCACTC TATATCCTGA AGGACAAGGA CTCCCGGGAG  
961 ACCGAGGAGA ACCCGGCCCC GGAGCCTCGA AGCGCGACGG AGCCCGGCCG GCCGAGCTAC  
1021 TCCGTGTCTC CCGCCGTGCC CGGCCGCTCG CCGGGGCTGC CCATCCGCTC TGCCCGCCGC  
1081 TACCCGCGCT CCCCAGCGCG CTCCCCAGCC ACCGGCCGGA CACACTCGTC GCCGCCCAGG  
25 1141 GCCCGGAGCT CGCCCGGCCG CTCGCGCAGC GCCTCGCGCA CACTGCGGAC TGCGGGCGTG  
1201 CACATAATCC GCGAGCAAGA CGAGGCCGGC CCGGTGGAGA TCAGCGCCTG A

## SEQ ID NO:16 (INSP052 Combined polypeptide sequence for exons 1,2,3,4,5,6 and 7.)

1 MKRERGAISR ASRALRLAPF VYLLLIQTDP LEGVNITSPV RLIHGTVGKS ALLSVQYSST  
61 SDRPVVKWQ LKRDKPVTVV QSIGTEVIGT LRPDYRDRIR LFENGSLLS DLQLADEGTY  
121 EVEISITDDT FTGEKTINLT VDVPISRPQV LVASTTVLEL SEAFITLNCSE ENGKPSYTW  
181 LKDGKPLND SRMLLSPDQK VLTITRVLME DDDLYSCMVE NPISQGRSLP VKITVYRRSS  
241 LYIILSTGGI FLLVTLVTVC ACWKPSKRKQ KKLEKQNSLE YMDQNDRLK PEADTLPRSG  
301 EQERKNPMAL YILKDKDSPE TEENPAPEPR SATEPGPPGY SVSPAVPGRS PGLPIRSARR  
35 361 YPRSPARSPA TGRTHSSPPR APSSPGRSRS ASRTLRTAGV HIIREQDEAG PVEISA

## SEQ ID NO:17 (INSP055 Mouse virtual cDNA)

1 ATGAAGAGAG AAAGGGGAGC CCTGTCAAGA GCCTCCAGGG CTCTGCGCCT CTCTCCTTTT  
61 GTCTACCTGC TTCTCATCCA GCCAGTCCCC CTGGAGGGGG TGAACATCAC CAGCCCAGTA  
40 121 CGTCTGATCC ACGGCACAGT GGGGAAGTCG GCCCTGCTTT CCGTGCAGTA CAGTAGCACC  
181 AGCAGCGACA AGCCCGTGGT GAAGTGGCAG CTGAAGCGTG ACAAGCCAGT ACCCGTGGTG  
241 CAGTCTATAG GCACAGAGGT CATTGGCACT CTGCGGCCTG ACTATCGAGA CCGTATCCGG  
301 CTCTTTGAAA ATGGCTCCTT GCTTCTCAGC GACCTGCAGC TGGCCGATGA GGGAACCTAT  
361 GAAGTGGAGA TTTCCATCAC TGACGACACC TTCACCGGGG AGAAGACCAT CAACCTCACC  
45 421 GTGGATGTGC CCATTTCAAG GCCGCAGGTA TTAGTGGCTT CAACCACTGT GCTGGAGCTC  
481 AGTGAGGCCT TCACCTCAA CTGCTCCCCT GAGAATGGCA CCAAGCCTAG CTACACGTGG  
541 CTGAAGGATG GCAAACCCCT CCTCAATGAC TCCCGAATGC TCCTGTCCCC TGACCAAAAG  
601 GTGCTCACCA TCACCCGAGT ACTCATGGAA GATGACGACC TGTACAGCTG TGTGGTGGAG  
661 AACCCCATCA GCCAGGTCCG CAGCCTGCCT GTCAAGATCA CTGTGTATAG AAGAAGCTCC  
50 721 CTCTATATCA TCTTGTCTAC AGGAGGCATC TTCTCTCTTG TGACCTTGGT GACAGTTTGT  
781 GCCTGCTGGA AACCTCAA AAAGTCTAGG AAGAAGAGGA AGTTGGAGAA GCAAACTCC  
841 TTGGAATACA TGGATCAGAA TGATGACCGC CTAAATCAG AAGCAGATAC CCTACCCCGA  
901 AGTGGAGAAC AGGAGCGGAA GAACCCAATG GCACTCTATA TCCTGAAGGA TAAGGATTCC  
961 TCAGAGCCAG ATGAAAACCC TGCTACAGAG CCACGGAGCA CCACAGAACC CGTCCCCCT  
55 1021 GGCTACTCCG TGTCGCCGCC CGTGCCCGGC CGCTCTCCGG GGCTTCCCAT CCGCTCAGCC  
1081 CCGCGCTACC CGCGCTCCCC AGCACGTTCC CCTGCCACTG GCCGGACGCA CACGTCGCCA  
1141 CGCGCGGCCG CGAGCTCGCC AGGCCGCTCG CGCAGCTCTT CGCGCTCACT CGCGCTGCA  
1201 GGCGTGCAGA GAATCCGGGA GCAGGACGAG TCAGGGCAGG TGGAGATCAG TGCCTGA

## 60 SEQ ID NO:18 (INSP055 Mouse Predicted Protein)

1 MKRERGAISR ASRALRLSPF VYLLLIQVPV LEGVNITSPV RLIHGTVGKS ALLSVQYSST  
61 SSDKPVVKWQ LKRDKPVTVV QSIGTEVIGT LRPDYRDRIR LFENGSLLS DLQLADEGTY  
121 EVEISITDDT FTGEKTINLT VDVPISRPQV LVASTTVLEL SEAFITLNCSE ENGKPSYTW  
181 LKDGKPLND SRMLLSPDQK VLTITRVLME DDDLYSCMVE NPISQGRSLP VKITVYRRSS  
65 241 LYIILSTGGI FLLVTLVTVC ACWKPSKRSR KKRKLEKQNS LEYMDQNDRLK LKSEADTLPR  
301 SGEQERKNPM ALYILKDKDS SEPDENPATE PRSTTEPGPP GYSVSPFPVP RSPGLPIRSA

361 RRYPRSPARS PATGRHTHTSP PRAPSSPGRS RSSSRSLRTA GVQRIREQDE SGQVEISA

SEQ ID NO:19 (nucleic acid sequence coding for extracellular domain of INSP052)

5 1 ATGAAGAGAG AAAGGGGAGC CCTGTCCAGA GCCTCCAGGG CCCTGCGCCT TGCTCCTTTT  
61 GTCTACCTTC TTCTGATCCA GACAGACCCC CTGGAGGGGG TGAACATCAC CAGCCCCGTG  
121 CGCCTGATCC ATGGCACCGT GGGGAAGTCG GCTCTGCTTT CTGTGCAGTA CAGCAGTACC  
181 AGCAGCGACA GGCCTGTAGT GAAGTGGCAG CTGAAGCGGG ACAAGCCAGT GACCGTGGTG  
241 CAGTCCATTG GCACAGAGGT CATCGGCACC CTGCGGCCTG ACTATCGAGA CCGTATCCGA  
301 CTCTTTGAAA ATGGCTCCCT GCTTCTCAGC GACCTGCAGC TGGCCGATGA GGGCACCTAT  
10 361 GAGGTCGAGA TCTCCATCAC CGACGACACC TTCCTGCGG AGAAGACCAT CAACCTTACT  
421 GTAGATGTGC CCATTTTCGAG GCCACAGGTG TTGGTGGCTT CAACCACTGT CTGGAGCTC  
481 AGCGAGGCCCT TCACCTTGAA CTGCTCACAT GAGAATGGCA CCAAGCCCAG CTACACCTGG  
541 CTGAAGGATG GCAAGCCCCCT CCTCAATGAC TCGAGAATGC TCCTGTCCCC CGACCAAAAG  
601 GTGCTACCA TCACCCGCGT GCTCATGGAG GATGACGACC TGTACAGCTG CATGGTGGAG  
15 661 AACCCCATCA GCCAGGGCCG CAGCCTGCCT GTCAAGATCA CCGTATACAG AAGAAGCTCC

SEQ ID NO:20 (extracellular domain of INSP052)

1 MKRERGAISR ASRALRLAPF VYLLLIQTDP LEGVNITSPV RLIHGTVGKS ALLSVQYSST  
61 SDRPVVKWQ LKRDKPVTVV QSIGTEVIGT LRPDYRDRIR LFENGSLLS DLQLADEGTY  
20 121 EVEISITDDT FTGEKTINLT VDVPISRPQV LVASTTVLEL SEAFITNCSH ENGKPSYTW  
181 LKDGKPLND SRMLLSPDQK VLTITRVLME DDLYSQRMVE NPISQGRSLP VKITVYRRSS

SEQ ID NO:21 (nucleic acid sequence coding for the extracellular domain of mature INSP052)

25 1 GTGAACATCA CCAGCCCCGT GCGCCTGATC CATGGCACCG TGGGGAAGTC  
51 GGCTCTGCTT TCTGTGCAGT ACAGCAGTAC CAGCAGCGAC AGGCCTGTAG  
101 TGAAGTGGCA GCTGAAGCGG GACAAGCCAG TGACCGTGGT GCAGTCCATT  
151 GGCACAGAGG TCATCGGCAC CCTGCGGCCT GACTATCGAG ACCGTATCCG  
201 ACTCTTTGAA AATGGCTCCC TGCTTCTCAG CGACCTGCAG CTGGCCGATG  
30 251 AGGGCACCTA TGAGGTCGAG ATCTCCATCA CCGACGACAC CTTCCTGCG  
301 GAGAAGACCA TCAACCTTAC TGTAGATGTG CCCATTTCTGA GGCCACAGGT  
351 GTTGGTGGCT TCAACCACTG TGCTGGAGCT CAGCGAGGCC TTCACCTTGA  
401 ACTGCTCACA TGAGAATGGC ACCAAGCCCC GCTACACCTG GCTGAAGGAT  
451 GGCAAGCCCC TCCTCAATGA CTCGAGAATG CTCCTGTCCC CCGACCAAAA  
35 501 GGTGCTCACC ATCACCCGCG TGCTCATGGA GGATGACGAC CTGTACAGCT  
551 GCATGGTGGG GAACCCCATC AGCCAGGGCC GCAGCCTGCC TGTCAAGATC  
601 ACCGTATACA GAAGAAGCTC C

SEQ ID NO:22 (extracellular domain of mature INSP052)

40 1 VNITSPVRLI HGTVGKSALL SVQYSSTSSD RPYVKWQLKR DKPVTVVQSI  
51 GTEVIGTLRP DYRDRIRLFE NGSLLSLDLQ LADEGTYEVE ISITDDTFTG  
101 EKTINLTVDV PISRPQVLVA STTVLELSEA FTLNCSHENG TKPSYTWLKD  
151 GKPLNDSRM LLSPDQKVLIT ITRVLMEDDD LYSCMVENPI SQGRSLPVKI  
201 TVYRRSS

SEQ ID NO 23: (Nucleotide sequence encoding the mature INSP052 exon2)

1 GTGAACATCA CCAGCCCCGT GCGCCTGATC CATGGCACCG TGGGGAAGTC  
51 GGCTCTGCTT TCTGTGCAGT ACAGCAGTAC CAGCAGCGAC AGGCCTGTAG  
101 TGAAGTGGCA GCTGAAGCGG GACAAGCCAG TGACCGTGGT GCAGTCCATT  
50 151 GGCACAGAGG TCATCGGCAC CCTGCGGCCT GACTATCGAG ACCGTATCCG  
201 ACTCTTTGAA AATGGCTCCC TGCTTCTCAG CGACCTGCAG CTGGCCGATG  
251 AGGGCACCTA TGAGGTCGAG ATCTCCATCA CCGACGACAC CTTCCTGCG  
301 GAGAAGACCA TCAACCTTAC TGTAGATG

55 SEQ ID NO 24: (Protein Sequence of Mature INSP052 Exon 2)

1 VNITSPVRLI HGTVGKSALL SVQYSSTSSD RPYVKWQLKR DKPVTVVQSI  
51 GTEVIGTLRP DYRDRIRLFE NGSLLSLDLQ LADEGTYEVE ISITDDTFTG  
101 EKTINLTVDV

60 SEQ ID NO :25 (nucleotide sequence encoding the mature INSP052 polypeptide)

1 GTGAACATCA CCAGCCCCGT GCGCCTGATC CATGGCACCG TGGGGAAGTC  
51 GGCTCTGCTT TCTGTGCAGT ACAGCAGTAC CAGCAGCGAC AGGCCTGTAG  
101 TGAAGTGGCA GCTGAAGCGG GACAAGCCAG TGACCGTGGT GCAGTCCATT  
151 GGCACAGAGG TCATCGGCAC CCTGCGGCCT GACTATCGAG ACCGTATCCG  
65 201 ACTCTTTGAA AATGGCTCCC TGCTTCTCAG CGACCTGCAG CTGGCCGATG  
251 AGGGCACCTA TGAGGTCGAG ATCTCCATCA CCGACGACAC CTTCCTGCG

301 GAGAAGACCA TCAACCTTAC TG TAGATGTG CCCATTTCTGA GGCCACAGGT  
 351 GTTGGTGGCT TCAACCACTG TGCTGGAGCT CAGCGAGGCC TTCACCTGA  
 401 ACTGCTCACA TGAGAATGGC ACCAAGCCCA GCTACACCTG GCTGAAGGAT  
 451 GGCAAGCCCC TCCTCAATGA CTCGAGAATG CTCCTGTCCC CCGACCAAAA  
 5 501 GGTGCTCACC ATCACC CGCG TGCTCATGGA GGATGACGAC CTGTACAGCT  
 551 GCATGGTGGA GAACCCCATC AGCCAGGGCC GCAGCCTGCC TGTCAAGATC  
 601 ACCGTATACA GAAGAAGCTC CCTTTACATC ATCTGTCTA CAGGAGGCAT  
 651 CTTCTCTCCTT GTGACCTTGG TGACAGTCTG TGCTGTCTGG AAACCTTCCA  
 701 AAAGGAAACA GAAGAAGCTA GAAAAGCAAA ACTCCCTGGA ATACATGGAT  
 10 751 CAGAATGATG ACCGCCTGAA ACCAGAAGCA GACACCCTCC CTCGAAGTGG  
 801 TGAGCAGGAA CGGAAGAACC CCATGGCACT CTATATCCTG AAGGACAAGG  
 851 ACTCCCCGGA GACCGAGGAG AACC CGGCCG CGGAGCCTCG AAGCGCGACG  
 901 GAGCCCGGCC CGCCCGGCTA CTCCGTGTCT CCCGCCGTGC CCGGCCGCTC  
 951 GCCGGGGCTG CCCATCCGCT CTGCCCGCCG CTACCCGCGC TCCCCAGCGC  
 15 1001 GCTCCCCAGC CACCGGCCG ACACACTCGT CGCCGCCAG GGCCCCGAGC  
 1051 TCGCCCGGCC GCTCGCGCAG CGCCTCGCGC AACTGCGGA CTGCGGGCGT  
 1101 GCACATAATC CGCGAGCAAG ACGAGGCCG CCCGTTGGAG ATCAGCGCCT  
 1151 GA

20 SEQ ID NO:26 (INSP052 mature polypeptide sequence)  
 1 VNITSPVRLI HGTVGKSALL SVQYSSTSSD RPVVKWQLKR DKPVTVVQSI  
 51 GTEVIGTLRP DYDRIRLFE NGSLLLSDLQ LADEGTYEVE ISITDDTFTG  
 101 EKTINLTVDV PISRPQVLVA STTVLELSEA FTLNCSHENG TKPSYTWLKD  
 151 GKPLNDSRM LLSPDQKVLT ITRVLMEDDD LYSCMVENPI SQGRSLPVKI  
 25 201 TVYRRSSLYI ILSTGGIFLL VTLVTVCAW KPSKRKQKKL EKQNSLEYMD  
 251 QNDDRLKPEA DTLPRSGEQE RKNPMALYIL KDKDSPETEE NPAPEPRSAT  
 301 EPGPPGYSVS PAVPGRSPGL PIRSARRYPR SPARSPATGR THSSPPRAPPS  
 351 SPGRSRSASR TLRTAGVHII REQDEAGPVE ISA

30 SEQ ID NO:27 (SEQIDNO880)  
 1 MKRREGALS R ASRALRLAPF VYLLLIQTDP LEGVNITSPV RLIHGTVGKS  
 51 ALLSVQYSST SDRPVVKWQ LKRDKPVTVV QSIGTEVIGT LRPDYRDRIR  
 101 LFENGSLLLS DLQLADEGTY EVEISITDDT FTGEKTINLT VDVPISRPQV  
 151 LVASTTVLEL SEAF TLNCSH ENG TKPSYTW LKDGKPLND SRMLLSPDQK  
 35 201 VLTITRVLME DDDL DSCVVE NPINQGR TLP CKITVYKKSS LSSIWLQEAF  
 251 SSLGPW

SEQ ID NO:28 (SEQIDNO434)  
 1 MKRREGALS R ASRALRLAPF VYLLLIQTDP LEGVNITSPV RLIHGTVGKS  
 40 51 ALLSVQYSST SDRPVVKWQ LKRDKPVTVV QSIGTEVIGT LRPDYRDRIR  
 101 LFENGSLLLS DLQLADEGTY EVEISITDDT FTGEKTINLT VDVPISRPQV  
 151 LVASTTVLEL SEAF TLNCSH ENG TKPSYTW LKDGKPLND SRMLLSPDQK  
 201 VLTITRVLME DDDL DSCVVE NPINQGR TLP CKITVYKKSS FYIICLKEAS  
 251 SSFPGW

45 SEQ ID NO:29 (histidine-tagged, extracellular domain of mature INSP052)  
 1 VNITSPVRLI HGTVGKSALL SVQYSSTSSD RPVVKWQLKR DKPVTVVQSI  
 51 GTEVIGTLRP DYDRIRLFE NGSLLLSDLQ LADEGTYEVE ISITDDTFTG  
 101 EKTINLTVDV PISRPQVLVA STTVLELSEA FTLNCSHENG TKPSYTWLKD  
 50 151 GKPLNDSRM LLSPDQKVLT ITRVLMEDDD LYSCMVENPI SQGRSLPVKI  
 201 TVYRRSSHHH HHH

SEQ ID NO:30 (Fc fusion of the extracellular domain of mature INSP052)  
 1 VNITSPVRLI HGTVGKSALL SVQYSSTSSD RPVVKWQLKR DKPVTVVQSI  
 55 51 GTEVIGTLRP DYDRIRLFE NGSLLLSDLQ LADEGTYEVE ISITDDTFTG  
 101 EKTINLTVDV PISRPQVLVA STTVLELSEA FTLNCSHENG TKPSYTWLKD  
 151 GKPLNDSRM LLSPDQKVLT ITRVLMEDDD LYSCMVENPI SQGRSLPVKI  
 201 TVYRRSSEPK SCDKTHTCPP CPAPELLGGP SVFLFPKPK DTLMISRTPE  
 251 VTCVVVDVSH EDPEVKFNWY VDGVEVHNAK TKPREEQYNS TYRVVSVLTV  
 60 301 LHQDWLNGKE YKCKVSNKAL PAPEKTISK AKGQPREPQV YTLPPSREEM  
 351 TKNQVSLTCL VKGFYPSDIA VEWESNGQPE NNYKTPPVVL DSDGSFFLYS  
 401 KLTVDKSRWQ QGNVFSCSVM HEALHNHYTQ KSLSLSPGK

SEQ ID NO:31 (INSP052Ig2)

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      1 VRLIHGTVGK SALLSVQYSS TSSDRPVVKW QLKRDKPVTV VQSIGTEVIG
      51 TLRPDYRDRI RLFENGSLLL SDLQLADEGT YEVEISITDD TFTGEKTINL
      101 TVDVPISRPQ VLVASTTVLE LSEAFTLNCS HENGTKPSYT WLKD GKPLLN
5     151 DSRMLLSPDQ KVL TITRVLM EDDDL YSCMV ENPISQ
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